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(71) Applicant: SHIMANO INC.
Osaka 590-8577 (JP)

(72) Inventor: Kimura, Yoshiki
Shimonoseki-shi, Yamaguchi (JP)

(74) Representative:
Herrmann-Trentepohl, Werner, Dipl.-Ing.
Patentanwälte
Herrmann-Trentepohl
Grosse - Bockhorni & Partner
Forstenrieder Allee 59
81476 München (DE)

(54) Bicycle shift control device

(57) To provide a bicycle shift control device that is unlikely to cause discomfort during a shifting procedure based on a simple control routine.

With the shift control component 25, speed steps are raised to the next level when the bicycle accelerates or is in first gear. An upshift mode is established. In this upshift mode, the speed steps are kept unchanged until they are in third gear (which is lower than the second gear), and are switched to a lower level when they are in third gear. On the other hand, the speed steps are switched to a lower level when they reach the second gear during deceleration if the upshift mode is not established. A downshift mode is established. In this downshift mode, the speed steps are kept unchanged until they are in fourth gear (which is higher than the first gear), and are switched to a higher level when they are in fourth gear. An upshift mode or a downshift mode is established when a shift is performed, the speed is changed to a gear (fourth or third) different from the regular shift gear (first or second), and shift timing is slowed down.

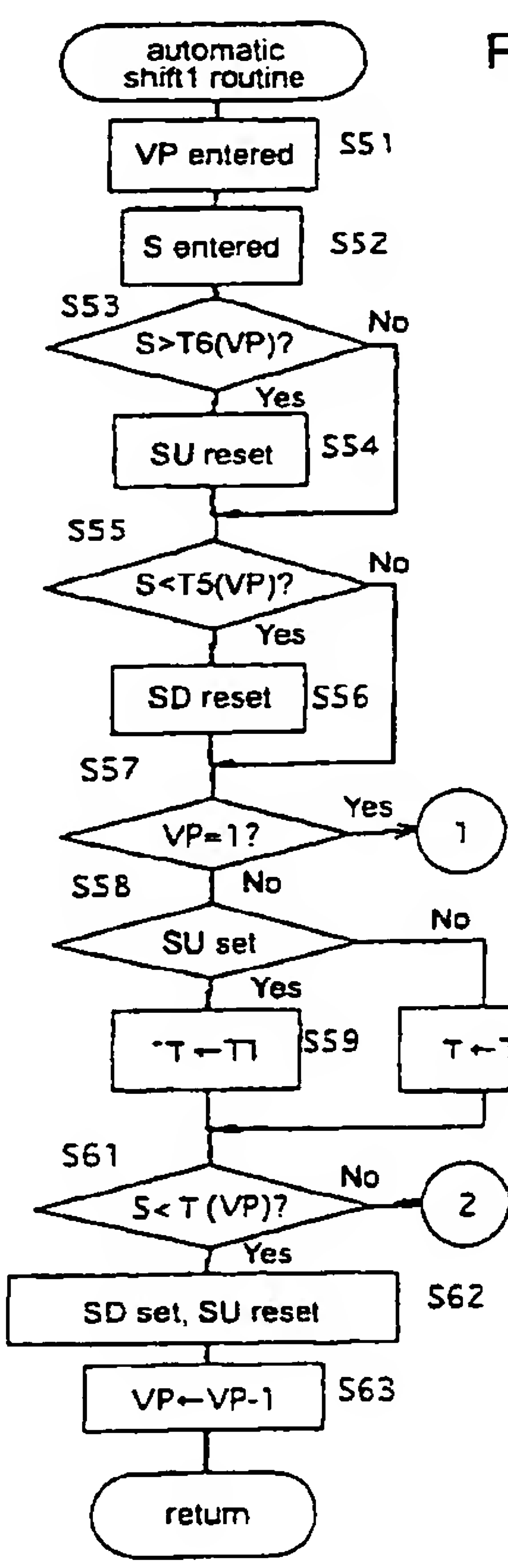

FIG. 14

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Description

[0001] The present invention relates to a shift control device, and more particularly to a bicycle shift control device for automatically switching a plurality of speed steps of a shifting mechnaism in accordance with the sensed speed of a bicycle.

[0002] Known bicycles are equipped with shifting mechanisms comprising a plurality of speed steps. The shifting mechanisms may be external shifting mechanisms or internal shifting mechanisms. An external shifting mechanism comprises, for example, a hub cog having a plurality of sprockets mounted on the rear wheel, and a derailleur for moving the chain between the sprockets. An internal shifting mechanism has an internal shifting hub. These shifting mechanisms are connected with the aid of shifting cables to shift levers attached to handles or the like. In bicycles provided with such shifting mechanisms, optimum speed steps suited to the riding conditions can be selected by the manual operation of the shift levers.

[0003] Shift levers are often placed close to the brake levers on a handle, however. During deceleration, the brake levers and the shift levers must be operated simultaneously, impairing shifting. In view of this, a shift control device for automatically switching speed steps in accordance with the speed of a bicycle has been proposed (Japanese Laid-Open Patent Application 8-113131). In this shift control device, the shift timing is varied depending on the magnitude of the increase or decrease in speed. In this case, the goal is to speed up the shift timing during fast acceleration or deceleration, reducing rider discomfort.

[0004] The aforementioned conventional mechanism allows the shift timing to be controlled not only on the basis of speed but also on the basis of acceleration. A need therefore exists for providing acceleration sensors or setting up routines for calculating acceleration on the basis of speed. Consequently, there is a possibility that complicated automatic shift control will be involved and that control response will be slower. In addition, control procedures are further complicated because the speed steps must be determined on the basis of complex two-dimensional maps when both speed and acceleration are used.

[0005] An object of the present invention is to provide a bicycle shift control device that is unlikely to cause discomfort during a shifting procedure based on a simple control routine.

[0006] The bicycle shift control device pertaining to invention 1, which is a device for automatically switching a plurality of speed steps of a shifting mechanism in accordance with the sensed speed of the bicycle comprises bicycle speed input means, first upshift means, first downshift means, upshift mode setting means, second downshift means, downshift mode setting means, and second upshift means. The bicycle speed input means is a means for entering the sensed bicycle speed. The first upshift means is a means for switching the speed steps from a lower step to a higher step when the bicycle is in first gear. The first downshift means is a means for switching the speed steps from a higher step to a lower step when the bicycle is in second gear. The upshift mode setting means is a means for setting an upshift mode when the first upshift means is actuated. The second downshift means is a means for switching the speed steps from a higher step to a lower step when the upshift mode has been set, and the bicycle speed has been changed from the second gear to a lower, third gear. The downshift mode setting means is a means for setting a downshift mode when the first downshift means has been actuated. The second upshift means is a means for switching the speed steps from a lower step to a higher step when the downshift mode has been set, and the bicycle speed has been changed from the first gear to a higher, fourth gear.

[0007] With this shift control device, the speed steps are switched one step higher when the bicycle starts moving, accelerates, and reaches first gear. An upshift mode is established. During such an upshift mode, the speed steps are kept in this state until they are in third gear (which is lower than the second gear), and are switched to a lower step when the third gear is reached. Meanwhile, the speed steps are switched to a lower step when the speed reaches the second step during deceleration if no downshift mode has been established. A downshift mode is thus established. During such a downshift mode, the speed steps are kept in this state until they reach the fourth gear (which is higher than the first gear), and are switched to a higher step when the fourth gear is engaged.

[0008] In this case, a single act of shifting establishes an upshift mode or a downshift mode, shifting is performed at a speed (fourth or third) different from a regular shifting speed (first or second), and the shift timing is changed. Specifically, the shift timing is slowed down such that the chain is moved to a lower, third gear when a downshift is performed in the downshift mode, and to a higher, fourth gear when an upshift is performed in the downshift mode, with shifting being performed at higher speeds during upshifting and at lower speeds during downshifting. The regular shift timing is thus speeded up. As a result, idle post-shifting can be reduced, and comfortable shifting can be performed in accordance with fast shift timing. In addition, comfortable shifting can be accomplished by a simple control procedure because the shift timing is established on the basis of speed alone.

[0009] The bicycle shift control device pertaining to invention 2, which is a device for automatically switching a plurality of speed steps of a shifting mechanism in accordance with the sensed speed of the bicycle, comprises bicycle speed input means, first upshift means, first downshift means, upshift mode setting means, second downshift means, downshift mode setting means, second upshift means, upshift mode release means,

and downshift mode release means. The bicycle speed input means is a means for entering the sensed bicycle speed. The first upshift means is a means for switching the speed steps from a lower step to a higher step when the bicycle is in first gear. The first downshift means is a means for switching the speed steps from a higher step to a lower step when the bicycle is in second gear. The upshift mode setting means is a means for setting an upshift mode when the first upshift means is actuated. The second downshift means is a means for switching the speed steps from a higher step to a lower step when the upshift mode has been set, and the bicycle speed has been changed from the second gear to a lower, third gear. The downshift mode setting means is a means for setting a downshift mode when the first downshift means has been actuated. The second upshift means is a means for switching the speed steps from a lower step to a higher step when the downshift mode has been set, and the bicycle speed has been changed from the first gear to a higher, fourth gear. The upshift mode release means is a means for releasing the upshift mode. The downshift mode release means is a means for releasing the downshift mode.

[0010] In this arrangement, means for canceling established downshift and upshift modes are provided in addition to invention 1. Even when these modes have been established, they are canceled once prescribed conditions are met, and the first or second gear is selected in accordance with the regular fast timing.

[0011] Furthermore, the bicycle shift control device as defined in connection with invention 2 provides that the upshift mode release means cancels the upshift mode in fifth gear, which is higher than the first gear, and the downshift mode release means cancels the downshift mode in sixth gear, which is lower than the second gear. In this case, chattering near the shift speed is less likely to occur because each mode is canceled in accordance with a timing that is slower than the regular shift timing.

[0012] The bicycle shift control device furthermore provides that the upshift mode release means and downshift mode release means have, respectively, a fifth gear group and a sixth gear group provided with respective settings for the fifth and sixth gears of each of the speed steps. In this case. each mode can be canceled by a simple control routine in which the current bicycle speed is compared with speed steps grouped into speed groups.

[0013] The bicycle shift control device furthermore provides that the downshift mode release means cancels the downshift mode when the bicycle speed reaches a speed that conforms to any of the sixth gears corresponding to the speed steps of the sixth gear group, or when the first or second upshift means is actuated. In this case, the downshift mode can be securely canceled.

[0014] The bicycle shift control device furthermore provides that the upshift mode release means cancels the upshift mode when the bicycle speed reaches a speed that conforms to any of the fifth gears corresponding to the speed steps of the fifth gear group, or when the first or second downshift means is actuated. In this case, the upshift mode can be securely canceled.

[0015] The bicycle shift control device furthermore provides that the first and second upshift means have, respectively, a first gear group and a fourth gear provided with respective settings for the first and fourth gears, which correspond to an upshift at each speed step; and the first and second downshift means have, respectively, a second gear group and a third gear group provided with respective settings for second and third gears, which correspond to a downshift at each speed step. In this case, shifting can be performed in accordance with a simple control routine in which the current bicycle speed is compared with speeds that correspond to speed steps grouped into speed groups.

[0016] The bicycle shift control device pertaining to invention 3, which is a device for automatically switching a plurality of speed steps of a shifting mechanism in accordance with the sensed speed of the bicycle, comprises bicycle speed input means, upshift means, first shift maintenance means, first downshift means, second shift maintenance means, and second downshift means. The bicycle speed input means is a means for entering the sensed bicycle speed. The upshift means is a means for upshifting the speed steps when the bicycle speed rises above speed A. The first shift maintenance means is a means for maintaining the upshifted speed steps when the bicycle speed has exceeded speed A but is still below a higher speed B. The first downshift means is a means for downshifting the speed steps maintained by the first shift maintenance means when the bicycle speed has dropped to speed C, wich is lower than speed A. The second shift maintenance means is a means for maintaining the upshifted speed steps when the bicycle speed has exceeded speed B and but is still below a higher speed D. The second downshift means is a means for downshifting the speed steps maintained by the second shift maintenance means when the bicycle speed has dropped to speed E, which is lower than speed B but higher than speed A.

[0017] The shift control device shifts up one step when the bicycle speed rises above speed A. The upshifted speed step is maintained while the bicycle speed remains above speed A but below speed B, and the speed step is also maintained while the bicycle speed remains below speed D. The device is downshifted one step when the bicycle speed drops to speed C while remaining below speed B, and a downshift is also performed when the bicycle speed drops to speed E after rising above B. In this case, the downshifting speed is lower (and the downshift timing is slower) than at a speed above a prescribed speed B while this speed is achieved with a single upshifting action. As a result, upshift-induced chattering is less likely to occur even when such upshifting is performed.

[0018] The bicycle shift control device pertaining to

invention 4, which is a device for automatically switching a pluraltiy of speed steps of a shifting mechanism in accordance with the sensed speed of the bicycle, comprises bicycle speed input means, downshift means, first shift maintenance means, first upshift means, second shift maintenance means, and second upshift means. The bicycle speed input means is a means for entering the sensed bicycle speed. The downshift means is a means for downshifting the speed steps when the bicycle speed has dropped below speed A. The first shift maintenance means is a means for maintaining the downshifted speed steps when the bicycle speed has dropped below speed A but is still above a lower speed B. The first upshift means is a means for upshifting the speed steps maintained by the first shift maintenance means when the bicycle spped has risen to speed C, which is higher than speed A. The second shift maintenance means is a means for maintaining the upshifted speed steps when the bicycle speed has dropped below speed B but is still above a lower speed D.The second upshift means is a means for upshifting the speed steps maintained by the second shift maintenance means when the bicycle speed has risen to speed E, which is higher than speed B but lower than speed A.

[0019] The shift control device shifts down one step when the bicycle speed falls below speed A. The downshifted speed step is maintained while the bicycle speed remains below speed A but above speed B, and the speed step is also maintained while the bicycle speed remains above speed D. The device is upshifted one step when the bicycle speed rises to speed C while remaining above speed B, and an upshift is also performed when the bicycle speed rises to speed E after dropping below B. In this case, the upshifting speed is higher (and the downshift timing is slower) than at a speed below a prescribed speed B while this speed is achieved with a single downshifting action. As a result, downshift-induced chattering is less likely to occur even when such downshifting is performed.

[0020] Further features, advantages of the subject matter of the invention derive from the attached drawings showing preferred embodiments of the invention, in detail:

Fig. 1 is a side view of a bicycle in which an embodiment of the present invention has been employed;

Fig. 2 is an oblique view of the handle portion thereof;

Fig. 3 is a block diagram of the structure of the control system:

Fig. 4 is a diagram illustrating examples of speed tables;

Fig. 5 is a longitudinal section of an interal shifting hub controlled in accordance with an embodiment of the present invention;

Fig. 6 is a diagram of the relationship between the drive pawls and the first sun gear when the bicycle is in fourth gear;

Fig. 7 is an enlarged cross-sectional diagram of the antiheft mechanism during normal riding;

Fig. 8 is an enlarged cross-sectional diagram of a locked antiheft mechanism;

Fig. 9 is a schematic illustrating the operation of a locked antiheft mechanism and an antiheft mechanism during riding;

Fig. 10 is a front view of the lock ring;

Fig. 11 is a flow chart of the main routine of shift control;

Fig. 12 is a flow chart of dial P routine;

Fig. 13 is a flow chart of password registration routine;

Fig. 14 is a flow chart of the automatic shift 1 routine;

Fig. 15 is a flow chart of the automatic shift 2 routine; and

Fig. 16 is a flow chart of the manual shift routine.

[0021] In Fig. 1, the bicycle in which an embodiment of the present invention is used is a recreational bicycle, comprising a frame 1 with a double loop type of frame unit 2 and front fork 3; a handle component 4; a drive component 5; a front wheel 6; a rear wheel 7 provided with a four-speed integral shifting hub 10; front and rear brake devices 8 (only the front one is shown in the figure); and a shift control element 9 for conveniently operating the internal shifting hub 10.

[0022] Various components, including a saddle 11 and a handle component 4, are attached to the frame 1. A bicycle speed sensor 12 furnished with a bicycle speed sensing lead switch is mounted on the front fork 3. This bicycle speed sensor 12 outputs a bicycle speed signal by sensing a magnet 13 mounted on the front wheel 6.

[0023] The handle component 4 has a handle stem 14 that is fixed to the upper portion of the front fork 3, and a handlebar 15 that is fixed to the handle stem 14. Brake levers 16 and grips 17 that constitute part of the brake devices 8 are mounted at either end of the handlebar 15. A shift control element 9 is mounted on the right-

side brake lever 16.

[0024] As shown in Fig. 2, the shift control element 9 has a control panel 20 formed integrally with the right-side (front-wheel) brake lever 16, two control buttons 21 and 22 disposed next to each other to the left and right on the lower portion of the control panel 20, a control dial 23 disposed above the control buttons 21 and 22, and a liquid-crystal display component 24 disposed to the left of the control dial 23. A shift control component 25 (Fig. 3) for controlling shifting operations is housed inside the control panel 20.

[0025] The control buttons 21 and 22 are triangular push buttons. The control button 21 on the left side is a button for performing shifts to a higher speed step from a lower speed step, while the control button 22 on the right side is a button for performing shifts to a lower speed step from a higher speed step. The control dial 23, which is a dial for switching among three shifting modes and a parking mode (P), has four stationary positions: P, A1, A2 and M. Here, the shift mode comprises an automatic shift 1 (A1) mode, an automatic shift 2 (A2) mode, and a manual shift (M) mode. The automatic shift 1 and 2 modes are for automatically shifting the internal shifting hub 10 by means of a bicycle speed signal from the bicycle speed sensor 12. The automatic shift 1 (A1) mode is a shift mode primarily used when automatic shifting is performed on level terrain, and the automatic shift 2 (A2) mode is a shifting mode primarily used when automatic shifting is performed on a slope. The automatic shift 2 (A2) mode is therefore set such that the shift timing for upshifts is faster than in the automatic shift 1 (A1) mode, whereas the shift timing for downshifts is slower than in the automatic shift 1 (A1) mode. The manual shift mode is for shifting the internal shifting hub 10 through the operation of the control buttons 21 and 22. The parking mode is for locking the internal shifting hub 10 and controlling the rotation of the rear wheel 7. The current riding speed is also displayed on the liquid-crystal display component 24, as is the speed step selected at the time of the shift.

[0026] The shift control component 25 comprises a microcomputer consisting of a CPU, a RAM, a ROM, and an I/O interface. As shown in Fig. 3, the shift control component 25 is connected to the bicycle speed sensor 12, an actuation position sensor 26 composed of a potentiometer (for example, a potentiometer that senses the actuation position of the internal shifting hub 10), the control dial 23, and the control buttons 21 and 22. The shift control component 25 is also connected to a power supply 27 (consisting of a battery), a motor driver 28, the liquid-crystal display component 24, a memory component 30, and other input/output components. A shift motor 29 is connected to the motor driver 28. The memory component 30 is composed of EEPROM or another type of rewritable nonvolatile memory. Various types of data, such as the password (PW) described below or the tire diameter, are sotred in the memory component. Also stored are six types of speed group data (hereinafter „speed tables") expressing respective relations between each speed step and the speeds during the automatic shift 1 (A1) mode and the automatic shift 2 (A2) mode. The shift control component 25 controls the motor 29 according to the various modes, and also controls the display of the liquid-crystal display component 24.

[0027] Fig. 4 depicts examples of the six speed tables used during the automatic shift 1 (A1) mode.

[0028] In Fig. 4, table 1 is a speed table containing a set speed (third gear) that corresponds to the downshifted speed steps achieved when the upshift mode described below has been set during the automatic shift 1 (A1) mode, and table 2 is a speed table containing a speed (second gear) that has been set during a regular downshift. Table 3 is a speed table containing a speed (first gear) that has been set during a regular upshift, and table 4 is a speed table containing a set speed (fourth gear) achieved during an upshift when the downshift mode described below has been set. Furthermore, table 5 ist a speed table containing a set speed (sixth gear) achieved when the downshift mode is canceled, and tabel 6 is a speed table containing a set speed (fifth gear) achieved when the upshift mode is canceled. Although the speed tables for the automatic shift 2 (A2) mode are not shown, the values in these tables tend to be lower overall than the corresponding speeds shown in Fig. 4. In each of these tables, the speed data are merely examples, and the numerical values thereof are not limited in any way.

[0029] The drive component 5 has a gear crank 18 that is provided to the lower portion (bottom bracket portion) of the frame body 2, a chain 19 that is wrapped around the gear crank 18, and the internal gear hub 10.

[0030] As shown in Fig. 5, the internal gear hub 10 primarily has a hub axle 41 that is fixed to the rear portion of the bicycle frame 1, a driver 42 that is located farther around the outer periphery at one end of the hub axle 41, a hub shell 43 that is located around the outer periphery of the hub axle 41 and driver 42, a planet gear mechanism 44 for transmitting motive power between the driver 42 and the hub shell 43, and an antiheft device 85. The planet gear mechanism 44 is made up of a total of four steps, one direct and three speed-increasing.

[0031] The driver 42 is a roughly cylindrical member, one end of which is rotatably supported by the hub axle 41 via balls 45 and a hub cone 46. A hub cog 47 is fixed as an input elment around the outer periphery at one end. A notch 42a that expands outward in the radial direction from the space in the center is formed in the driver 42. Three of these notches 42a are formed at roughly equal angles in the circumferential direction.

[0032] The hub shell 43 is a cylindrical member having a plurality of steps in the axial direction, and the driver 42 is housed in a housing space 43a around the inner periphery thereof. One side of the hub shell 43 is rotat-

ably supported around the outer periphery of the driver 42 via balls 50, and the other by the hub axle 41 via balls 51 and a hub cone 52. Flanges 53 and 54 for supporting the spokes 7a (Fig. 1) of the rear wheel 7 are fixed around the outer periphery at both ends of the hub shell 43. A cover 55 is fixed to the outer side wall at one end of the driver 42, and the distal end of the cover 55 extends so as to cover the outer peripheral surface at one end of the hub shell 43. A sealing member 56 is positioned between the inner peripheral surface at the distal end of the cover 55, and the outer peripheral surface of the hub shell 43.

[0033] The planet gear mechanism 44 is housed in the housing space 43a inside the hub shell 43, and has first, second, and third sun gears 60, 61, and 62, three planet gears 63 (only one planet gear is shown in the figures) that mesh with these, and a ring gear 64. The sun gears 60 to 62 are lined up in the axial direction around the inner periphery of the driver 42 and the outer periphery of the hub axle 41, and are allowed to rotate relative to the hub axle 41. The planet gears 63 are rotatably supported via a support pin 65 within the notches 42a in the driver 42. A first gear 63a, a second gear 63b, and a third gear 63c are formed integrally with the planet gears 63. The first gear 63a meshes with the first sun gear 60, the second gear 63b meshes with the second sun gear 61, and the third gear 63c meshes with the third sun gear 62. The ring gear 64 is located on the outer peripheral side of the planet gears 63, and inner teeth are formed around the inner periphery. This ring gear 64 meshes with the second gear 63b of the planet gears 63.

[0034] As shown in Fig. 6, a pair of stopping protrusions 41 a are formed at the locations where the sun gears 60 to 62 (sun gear 60 alone is shown in Fig. 6) are disposed around the external peripheral section of the hub axle 41. In addition, four housing spaces 60a to 62a are formed apart from each other in the peripheral direction around the inner periphery of the sun gears 60 to 62.

[0035] Between the hub axle 41 and the inner periphery of the sun gears 60 to 62 are positioned a selective clutch mechanism 70 for preventing the sun gears 60 to 62 from performing relative rotation in the forward direction or for allowing them to rotate relative to the hub axle 41, and an actuation mechanism 91 for actuating the selective clutch mechanism 70, as shown in Fig. 5.

[0036] The selective clutch mechanism 70 has a function whereby it selectively links one of the three sun gears 60 to 62 to the hub axle 41, and a function whereby it does not link any of the sun gears 60 to 62 to the hub axle 41. The selective clutch mechanism 70 has a plurality of drive pawls 71, 72, and 73 whose distal ends can mesh with the stopping protrusions 41a of the hub axle 41, and has annular wire springs 74, 75, and 76 for energizing the distal ends of the drive pawls 71 to 73 toward the hub axle 41. The drive pawls 71 to 73 are disposed in two out of the four spaces 60a to 62a for the corresponding sun gears 60 to 62, are swingably supported at their base ends in the facing spaces 60a to 62a, and are able to mesh at their distal ends with the stopping protrusions 41a. When the drive pawls 71 to 73 are stopped by the stopping protrusions 41a of the hub axle 41, and are thereby linked to the hub axle 41, the sun gears 60 to 62 are no longer able to rotate in the forward direction (clockwise in Fig. 6) in relation to the hub axle 41 but can perform relative rotation in the opposite direction (counterclockwise in Fig. 6). When the drive pawls are released, relative rotation is possible in both directions.

[0037] The actuation mechanism 91 has a sleeve 77. The sleeve 77 is rotatably fitted over the outer periphery of the hub axle 41, and has a plurality of drive cam components 94a at the locations where the drive pawls 71 to 73 are disposed on the outer periphery. When these drive cam components 94a strike any of the drive pawls 71 to 73, the struck pawls are raised, and the linkage between the hub axle 41 and the sun gears 60 to 62 is released by these pawls. An operator 78 is fixed to one end of the sleeve 77, and the sleeve 77 can be rotated by the rotation of the operator 78. The rotation of the sleeve 77 then causes the drive cam components 94a to selectively actuate the drive pawls 71 to 73, so that the linkage of the sun gears 60 to 62 with the hub axle 41 is controlled.

[0038] As shown in Fig. 5, a reduction mechanism 95 is linked to the operator 78. The reduction mechanism 95 reduces the speed of rotation of the shift motor 29, and transmits it to the operator 78. The actuation position sensor 26, which is used to fix the sleeve 77 of the internal shifting hub 10 in one of the actuation positions VP (in one of the shift positions V1 to V4 of the speed steps or in the locked position PK), is disposed inside the reduction mechanism 95.

[0039] With such a structure, a large speed-increasing power transmission path (corresponds to shift position V4) with the largest speed increasing ratio is created when the drive pawl 71 strikes a stopping protrusion 41a of the hub axle 41, and the first sun gear 60 is selected; a medium speed-increasing power transmission path (corresponds to shift position V3) with the second-largest speed increasing ratio is created when the second sun gear 61 is selected; and a small speed-increasing power transmission path (corresponds to shift position V2) with the smallest speed increasing ratio is created when the third sun gear 62 is selected. If none of the sun gears has been selected, then a direct-coupled power transmission path (corresponds to shift position V1) is created.

[0040] A first one-way clutch 80 is provided between the inner peripheral surface of the hub shell 43 and the outer peripheral surface at the other end of the driver 42. A second one-way clutch 81 is provided between the inner peripheral surface of the hub shell 43 and the outer peripheral surface of the ring gear 64. These one-way clutches 80 and 81 are both roller-type, one-way

clutches that make it possible to reduce noise during idle running when a shift is made, to soften the shock when a shift is made, and to perform smoother shifting.

[0041] The antitheft device 85 is provided to the left end (in Fig. 5) of the hub axle 41 within the hub shell 43. As shown in Fig s. 7 to 10, the antitheft device 85 has a spring washer 101 that rotates integrally with the sleeve 77, a moving cam 102, a moving member 103, a moving spring 104, and a lock ring 114. The moving cam 102 is nonrotatably installed while allowed to move axlially in relation to the hub axle 41. The moving member 103 presses against the moving cam 102. The moving spring 104 is disposed in a compressed state between the moving member 103 and a hub cone 52. The lock ring 114 is pressed against the moving member 103.

[0042] The spring washer 101 is a member that is nonrotatably stopped by the sleeve 77, and has around its outer periphery an engagement tab 105 that strikes the moving cam 102. The moving cam 102 has a cylindrical cam body 106 and a stopping washer 107 that stops the cam body 106 and the hub axle 41 such that they can move in the axial direction but cannot rotate. A cam component 108 that strikes the engagement tab 105 is formed at the right end (in Fig. 9) of the cam body 106. The cam component 108 is formed such that the cam body 106 is moved axilally to the right only when the sleeve 77 rotates toward the locked position PK.

[0043] The moving member 103 has a disk-shaped flange component 115 and a cylindrical component 116 integrally formed along the inner periphery of the flange component 115. A step 115a is formed on the flange component 115 in its mid-portion, as viewed in the radial direction. The lock ring 114 is rotatably supported by the step 115a. As shown in Fig. 10, respective radial irregularities 114a (only those located on the side facing the lock ring 114 are shown) are formed on that surface of the flange component 115 which faces the lock ring 114 and on that surface of the lock ring 114 which faces the flange component 115. The presence of such irregularities 114a increases the frictional force between the lock ring 114 and the moving member 103 and causes these components to vibrate and to produce sound during relative rotation. Serration teeth 114b are formed in the outer peripheral portion of the lock ring 114. These serration teeth 114b can engage with serration teeth 113 formed in the inner peripheral surface of the hub shell 43.

[0044] Four protrusions 116a are formed on the inner peripheral surface of the cylindrical component 116, as shown in Fig. 10. The protrusions 116a engage four grooves 41b formed in the outer peripheral surface of the hub axle 41. As a result of this arrangement, the moving member 103 is nonrotatably supported by the hub axle 41 while allowed to move in the axial direction. A thread and a stopping groove are formed in the outer peripheral surface of the cylindrical component 116. A pressure ring 117 is mounted around the outside of the cylindrical component 116, as shown in Fig. 7. The pressure ring 117, which is nonrotatably supported on the cylindrical component 116 while allowed to move in the axial direction, is allowed to come into contact with the lock ring 114. In addition, a pressure nut 118 is screwed on the outer periphery at the right end of the cylindrical component 116. A coned disk spring 119 is disposed between the pressure nut 118 and the pressure ring 117.

[0045] Here, the pressure exerted by the coned disk spring 119 can be adjusted by adjusting the fastening of the pressure nut 118; the frictional force between the lock ring 114 and the flange component 115 of the moving member 103 can be adjusted via the pressure ring 117; and the rotation of the hub shell 43 can be controlled arbitrarily. For example, maximizing the frictional force produced by the coned disk spring 119 makes it possible to bring the hub shell 43 into a locked state. Furthermore, reducing the frictional force weakens the force with which the rotation of the hub shell 43 is controlled and allows the hub shell 43 to rotate in relation to the hub axle 41. In this case as well, a frictional force is generated when the coned disk spring 119 is energized, and the rotation is controlled, unlike in a free-rotating state. This embodiment allows the rotation of the hub shell 43 (that is, the rotation of the rear wheel 7) to be freely controlled by adjusting the energizing force of the coned disk spring 119 within a range that extends essentially from a locked state to a free-rotating state.

[0046] Shifting and locking are performed by actuating the shift motor 29 through mode selection with the control dial 23 of the shift control element 9 and through shifting with the control buttons 21 and 22, and by rotating the sleeve 77 via the operator 78.

[0047] Fig. 11 is a flow chart illustrating the control routine of the shift control component 25.

[0048] When the power is turned on, initialization is performed in step S1. Here, circumference data used for calculating speed is set to a diameter of 26 inches, the speed step is set to the second gear (V2), and various flags are reset.

[0049] In step S2, a decision is made as to whether the control dial 23 has been set to the parking mode. In step S3, a decision is made as to whether the control dial 23 has been set to the automatic shift 1 mode. In step S4, a decision is made as to whether the control dial 23 has been set to the automatic shift 2 mode. In step S5, a decision is made as to whether the control dial 23 has been set to the manual shift mode. In step S6, a decision is made as to whether some other routine, such as tire diameter input, has been selected.

[0050] When the control dial 23 is turned to position P and is set to the parking mode, the operation proceeds from step S2 to step S10. In step S10, the dial P routine shown in Fig. 12 is executed. When the control dial 23 is turned to position A1 and set to the automatic shift 1 mode, the operation proceeds from step S3 to step S11. In step S11, the automatic shift 1 routine shown in Figs. 14 and 15 is executed. When the control dial 23 is

turned to position A2 and is set to the automatic shift 2 mode, the operation proceeds from step S4 to step S12. In step S12, the automatic shift 2 routine shown is executed in the same manner as the automatic shift 1 routine. When the control dial 23 is turned to position M and is set to the manual shift mode, the operation proceeds from step S5 to step S13. In step S13, the manual shift routine shown in Fig. 16 is executed. When another routine is selected, the operation proceeds from step S6 to step S14, and the selected routine is executed.

[0051] With the dial P routine in step S10, a decision is made as to whether 30 seconds have elapsed since the dial was turned to position P in step S21 in Fig. 12. In step S22, a decision is made as to whether a password PW has been registered. This decision is made on the basis of whether the password PW has already been stored in the memory component 30. If the password has already been registered, the operation proceeds to step S23.

[0052] In step S23 a decision is made as to whether the left control button 21 has been operated. The purpose of operating the control buttons 21 and 22 here is to enter the password for unlocking the locked internal shifting hub 10. In step S24 a decision is made as to whether the right control button 22 has been operated. In step S25 a decision is made as to whether the password LR entered by operation of the two control buttons 21 and 22 matches the registered password PW. If there is no match, the operation proceeds to step S26. In step S26 a decision is made as to whether the password still does not match after it has been entered three times. If it has yet to be entered three times, the operation returns to step S23, and reentering of the password is permitted. If the password does not match the registered password PW after being entered three times, the operation proceeds to step S27. In step S27, the system waits for 10 minutes to pass, and when 10 minutes have elapsed, the operation returns to step S23, and reentering of the password is permitted.

[0053] Once 30 seconds have elapsed since the dial was turned to position P, the operation proceeds from step S21 to step S30. In step S30, the shift motor 29 is driven by the motor driver 28, and the actuation position VP is set to the locked position PK. As a result, the sleeve 77 is rotated to the locked position via the operator 78. The engagement tab 105 of the spring washer 101 rotating together with the sleeve 77 moves into the cam component 108a when the sleeve 77 is rotated from a shift position to the locked position PK. When the engagement tab 105 moves into the cam component 108, the moving cam 102 and the moving member 103 energized by the moving spring 104 move to the right from the position shown in Figs. 7 and 9A to the position shown in Figs. 8 and 9B. As a result, the serration teeth 114b of the lock ring 114 engage with the serration teeth 113 of the hub shell 43, and the rotation of the hub shell 43 is controlled by the force of friction between the lock ring 114 and the moving member 103. The corresponding frictional force can be altered as needed by adjusting the energizing force of the coned disk spring 119 through the tightening of the pressure nut 118. Therefore, pedaling fails to rotate the rear wheel 7 or is difficult to accomplish.

[0054] At this time, an attempt to forcefully turn the hub shell 43 results in the relative rotation of the moving member 103 and the lock ring 114, and causes the lock ring 114 and the moving member 103 to vibrate and to emit a loud vibrating noise under the action of the irregularities 114a. Thus, loud noise is produced when the bicycle is pushed by hand or the pedals are pressed and the hub shell 43 is rotated in the locked state, making the bicycle more difficult to steal. Another feature is that even when the sleeve 77 is mistakenly placed in the locked position by an accidental action during riding, the rear wheel 7 is still prevented from being locked abruptly because the rotation of the rear wheel 7 is controlled by friction.

[0055] In addition, the hub shell 43 is locked by being coupled directly with the hub axle 41, so the rotation of the hub shell 43 (rear wheel 7) is impeded even when an attempt is made to push the bicycle, making the bicycle more difficult to move and reducing the likelihood of a theft.

[0056] If the password PW has not been registered, the operation proceeds from step S22 to step S31. In step S31, the code registration routine illustrated in Fig. 13 is executed. Here, a decision is made as to whether the control button 21 has been operated in step S41 in Fig. 13. If the control button 21 has been operated, the operation proceeds to step S42, and the left number L (a ten-digit number) is increased by one. In step S43 a decision is made as to whether the control button 22 has been operated. The operation returns to step S41 until the control button 22 is pushed, and the left number L is increased by one. When the control button 22 is operated, the operation proceeds to step S44, and the right number R (a one-digit number) is increased by one. In step S45 a decision is made as to whether the control button 21 was operated again. The operation returns to step S43 until the control button 21 is operated, and the right number R is increased by one. When the control button 21 is operated, the operation proceeds to step S46, and the inputted number LR is stored as the password PW in the memory component 30. A password PW is thus registered after being selected from among 100 two-digit numbers LR ranging from "00" to "99."

[0057] The operation proceeds to step S32 if it is decided in step S23 that the control button 21 was operated during unlocking. In step S32 the left number L is increased by one, just as when the password was registered. If it is decided that the control button 22 was operated, the operation proceeds from step S24 to step S33. In step S32, the right number R is increased by one, just as when the password was registered. If the entered number LR matches the password PW in step S25, the

operation proceeds to step S34, and the actuation position VP is set to first gear V1. As a result, the sleeve 77 is rotated by the shift motor 29 and positioned at the first gear V1, releasing the engagement between the lock ring 1 14 and the serration teeth 113 of the hub shell 43. As a result, when the bicycle is pedaled, the rotation of the driver 42 is transmitted unchanged to the hub shell 43 via the first one-way clutch 80.

[0058] With the automatic shift 1 routine of step S11, the actuation position VP is set to the speed step corresponding to the bicycle speed SP. When the position is different from this, shifts are made one gear at a time toward this. Here, in step S51 in Fig. 14, the actuation position VP of the actuation position sensor 26 is entered.

[0059] In step S52, the current bicycle speed S is entered based on the speed signal from the bicycle speed sensor 12. In step S53, it is determined whether the currently bicycle speed S thus entered exceeds the cancel speed T6 (VP) at the actuation position VP indicating the current speed step in table 6. As shown above, table 6 is a speed table for canceling (resetting) the upshift mode, and, as shown in Fig. 4, the corresponding value is, for exarnple, 14 km/h when VP = 2.

[0060] The upshift mode and the downshift mode will now be described.

[0061] The upshift mode is a shift mode established when an upshift is made. Chattering, which involves rapidly alternating upshifts and downshifts, occurs when downshifts are performed at speeds close to those achieved following upshifts. Slower than usual downshifts are performed in the upshift mode to prevent this phenomenon. Table 1 (T1) is the speed table used in the upshift mode. Similarly, the downshift mode is a shift mode established when a downshift is made. Faster than usual upshifts are performed in the downshift mode to prevent chattering during downshifts. Table 4 (T4) is the speed table used in the downshift mode. In addition, table 3 (T3) is used during a regular upshift, and table 2 (T2) is used during a downshift. The two tables 3 and 2 have faster upshift and downshift timing patterns than do tables 4 and 1. Furthermore, table 6 (T6) and table 5 (T5) are speed tables for canceling these upshift and downshift modes and returning to regular shift timing.

[0062] The operation proceeds to step S54 if the bicycle speed S exceeds the cancel speed T6 (VP) of table 6. The upshift flag SU indicating that the operation has been set to the upshift mode is reset during step S54. This procedure is skipped if the bicycle speed S does not exceed the cancel speed T6 (VP) of table 6.

[0063] In step S55, it is determined whether or not the bicycle speed S is below a cancel speed T5 (VP) corresponding to a speed step of table 5. As described above, this table 5 is a speed table for canceling (resetting) the downshift mode. As shown in Fig. 4, the value is, for example, 14 km/h when VP = 2. The operation proceeds to step S56 if the bicycle speed S is below the cancel speed T5 (VP) of table 5. The downshift flag SD indicating that the operation has been set to a downshift mode is reset during step S56. This procedure is skipped if the bicycle speed S exceeds the cancel speed T6 (VP) of table 6.

[0064] In step S57, it is determined whether or not the speed step corresponds to the first gear (whether or not the actuation position is V1). The operation proceeds to step S58 if the speed step corresponds to the first gear. In step S58, it is determined whether or not the upshift flag SU has already been set up, that is, whether or not an upshift mode has been set. The operation proceeds to step S59 if the upshift mode has been established, and table 1 (T1) is selected as the downshift speed table. The operation proceeds to step S60 if the upshift mode has not been established, and table 2 (T2) is selected as the downshift speed table.

[0065] It is determined during step S61 whether or not the current bicycle speed S is below a shift speed T (VP) corresponding to a speed step of the selected table. In other words, it is determined whether or not the bicycle speed S has dropped below the shift speed corresponding to the current speed step. If the bicycle speed S has dropped below the shift speed, the operation proceeds to step S62, a downshift flag is set up, a downshift mode is established, an upshift flag SU is set up, and the upshift mode is canceled. During step S63, the actuation position VP is reduced one level in order to downshift the speed step by one level, returning the operation to the main-routine in Fig. 11.

[0066] The operation proceeds from step S61 to the step S64 in Fig. 15 if the current bicycle speed S is equal to or greater than a shift speed T (VP)corresponding to a speed step of the selected table. In step S64, it is determined whether or not the actuation position is V4, that is, whether or not the speed step corresponds to the fourth gear. The operation returns to the main routine if the speed step corresponds to the fourth gear. The operation proceeds to step S65 if the speed step does not correspond to the fourth gear, that is, if the speed step corresponds to any of first through third gears. In step S65, it is determined whether or not a downshift flag SD has already been set up, that is, whether the downshift mode has been established. If the downshift mode has been established, the operation proceeds to step S66, and table 4 (T4) is selected as an upshift speed table. If the downshift mode has not been established, the operation proceeds to step S67, and table 3 (T3) is selected as an upshift speed table. In step S68, it is determined whether or not the current bicycle speed S exceeds a shift speed (VP) corresponding to a speed step of the selected table. In other words, it is determined whether or not the bicycle speed S has risen above the shift speed corresponding to the current speed step. If the bicycle speed S has risen above the shift speed, the operation proceeds to step S69, an upshift flag is set up, an upshift mode is estabtished, the downshift flag is reset, and the downshift mode is can-

celed. During step S70, the actuation position VP is raised one level in order to upshift the speed step by one level, returning the operation to the main routine in Fig. 1 1.

[0067] On the other hand, the operation proceeds to step S65 if it has been determined during step S57 that the speed step corresponds to the first gear.

[0068] Specifically, first gear V1 is initially established because of low speed when the automatic shift 1 routine is performed, that is, when the foot is placed on the pedal, and the bicycle starts moving. If no downshift mode has been established, table 3 is selected, and when bicycle speed S exceeds 11 Km/h, the speed is upshifted to second gear V2, and an upshift mode is established. If the step S then exceeds 14 km/h, the upshift mode is canceled on the basis of table 6. If the bicycle accelerates even further and the bicycle speed exceeds 16 km/h, the speed is upshifted to third gear V3 on the basis of table 3.

[0069] In a reverse case, that is, when the bicycle speed S continues to decrease without exceeding 14 km/h, table 1 is selected because the bicycle is still operating in an upshift mode, and no downshift is performed until the speed drops below 9 km/h.

[0070] On the other hand, when the bicycle speed S continues to decrease after exceeding 14 km/h, table 2 is selected, and a downshift is performed until the speed drops below 12 km/h. Performing a downshift cancels the upshift mode and establishes a downshift mode. The downshift mode is canceled on the basis of table 5 once the bicycle speed S has dropped below 8 km/h. For this reason, an increase in the bicycle speed S from a level of 8 km/h results in the selection of table 4 and in an upshift to 14 km/h, whereas an increase in the bicycle speed S from a level below 8 km/h results in the selection of table 3 and in an upshift once 11 km/h is exceeded.

[0071] Thus, a shift causes the automatic shift 1 routine to enter an upshift mode or a downshift mode, and the shift timing is slowed down in accordance with table 4 or 1 until the speed is increased or reduced to the prescribed cancel speed specified by table 6 or 5, making it possible to prevent chattering even when the shift is made prematurely. Smooth speed switching can thus be accomplished with minimal discomfort.

[0072] Here, when the first sun gear 60 is linked to the hub axle 41 by the shift motor 29, the bicycle is in fourth gear, the rotation provided from the hub cog 47 to the driver 42 is increased by the largest gear ratio (which is determined by the number of teeth on the first sun gear 60, the first gear 63a and second gear 63b of the planet gears 63, and the ring gear 64), and this rotation is transmitted to the hub shell 43 via the second one-way clutch 81. When the second sun gear 61 is selected and linked to the hub axle 41, the bicycle is in third gear, the rotation of the driver 42 is increased by a medium (the second largest) gear ratio (which is determined by the number of teeth on the second sun gear 61, the second gear 63b of the planet gears 63, and the ring gear 64), and this rotation is transmitted to the hub shell 43 via the second one-way clutch 81. When the third sun gear 62 is selected and linked to the hub axle 41, the bicycle is in second gear, the rotation of the driver 42 is increased by the smallest gear ratio (which is determined by the number of teeth on the third sun gear 62, the second gear 63b and third gear 63c of the planet gears 63, and the ring gear 64), and this rotation is transmitted to the hub shell 43 via the second one-way clutch 81. If none of the sun gears 60 through 62 is selected, the first gear is engaged as described above, and the rotation of the driver 42 is transmitted directly to the hub shell 43.

[0073] Unselected sun gears perform relative rotation in the opposite direction from the forward direction with respect to the hub axle 41. When any one of the sun gears is selected and the speed is increased by the planet gear mechanism 44, the driver 42 and the hub shell 43 perform relative rotation in the direction in which meshing with the first oneway clutch 80 is released.

[0074] A detailed description of the automatic shift 2 routine will be omitted because the only difference between this routine and the automatic shift 1 routine are the tables used for the routines. Specifically, tables 1 through 6 are set to lower speeds than in the automatic shift 1 routine.

[0075] With the manual shift routine of step S11, gear shifts are made one at a time by operation of the control buttons 21 and 22. In step S71 in Fig. 16, the actuation position VP of the actuation position sensor 26 is entered. In step S72, a decision is made as to whether the control button 21 has been operated. In step S73, a decision is made as to whether the control button 22 has been operated. When the control button 21 is operated, the operation proceeds from step S72 to step S74. In step S74, a decision is made as to whether the current actuation position VP is V4, which corresponds to the fourth gear. If the current actuation position VP is not V4, the operation proceeds to step S75, and the actuation position VP is moved one speed step higher, executing a one-step upshift. If the current actuation position VP is V4, this routine is skipped.

[0076] When the control button 22 is operated, the operation proceeds from step S73 to step S76. In step S76, a decision is made as to whether current actuation position VP is V1, which corresponds to the first gear. If the current actuation position VP is not V1, the operation proceeds to step S77, and the actuation position VP is moved one speed step lower, executing a one-step downshift. If the current actuation position VP is V1, this routine is skipped.

[0077] The present embodiment thus allows an upshift mode and a downshift mode to be established for the automatic shift 1 routine, with shifting performed in accordance with a slower than usual timing pattern, and chattering prevented, until the speed is raised or lowered to a prescribed level when a shift is performed,

making it possible to perform automatic shifting with minimal discomfort by means of a simple control procedure based on the use of speed alone without the use of acceleration.

(a) Although the above embodiment was described with reference to an internal shifting hub as a shifting mechanism, the present invention is also applicable to a shifting mechanism in the form of an external shifting mechanism composed of a plurality of sprockets and derailleurs.

(b) Although the above embodiment was described with reference to a shifting mechanism actuated by a shifting motor, the present invention is also applicable to a shifting mechanism actuated by a solenoid, an electric/hydraulic/ pneumatic cylinder, or another actuator.

[0078] According to the present invention, an upshift mode or a downshift mode is established when a shift is performed, the speed is changed to a gear different from the regular shift gear, and the pattern shift timing is altered. Specifically, the pattern of shift timing is slowed down such that shifting is performed at lower speeds when a downshift is performed in the upshift mode, and at higher speeds when an upshift is performed in the downshift mode. Regular shift timing is accelerated. As a result, idle post-shifting can be reduced, and comfortable shifting can be performed in accordance with fast shift timing. In addition, comfortable shifting can be accomplished by a simple control procedure because the shift timing is established on the basis of speed alone.

List of reference numerals

[0079]

1	frame
2	frame unit
3	front fork
4	handle component
5	drive component
6	front wheel
7	rear wheel
7a	spokes
8	front, rear brake devices
9	shift control element
10	internal shifting hub
11	saddle
12	bicyle speed sensor
13	magnet
14	handle stem
15	handlebar
16	brake levers
17	grips
18	gear crank
19	chain
20	control panel
21	control button
22	control button
23	control dial
24	liquid-crystal display component
25	shift control component
26	actuation position sensor
27	power supply
28	motor driver
29	shift motor
30	memory component
41	hub axle
41a	stopping protrusion
41b	grooves
42	driver
42a	notch
43	hub shell
43a	housing space
44	planet gear mechanism
45	balls
46	hub cone
47	hub cog
50	balls
51	balls
52	hub cone
53, 54	flanges
55	cover
56	saeling member
60, 61, 62	sun gear
60a to 62a	our housing spaces
63	planet gear
63a	first gear
63b	second gear
63c	third gear
64	ring gear
65	support pin
70	clutch mechanism
71, 72, 73	drive pawls
74, 75, 76	annular wire spring
77	sleeve
78	operator
80	first one-way clutch
81	second one-way clutch
85	antitheft device
91	actuating mechanism
94a	drive cam components
95	reduction mechanism
101	spring washer
102	moving cam
103	moving member
104	moving spring
105	engagement tab
106	cylindrical cam body
107	stopping washer
108	cam component
113	serration teeth

114	lock spring
114a	radial irregularities
114b	serration teeth
115	disk shaped flange component
115a	step
116	cylindrical component
116a	protrusions
117	pressure ring
118	pressure nut
119	coned disk spring
P	parking mode
A1	automatic shift 1
A2	automatic shift 2
M	manual shift
VP	actuation position
V1 to V4	shift position
PK	locked position
PW	password
LR	password
L	left number
R	right number
A, B, C, D, E, S, SP	bicycle speed
SU	upshift flag
SD	downshift flag
T	shift speed
S1 to S6	steps
S10 to S14	steps
S21 to S34	steps
S41 to S46	steps
S51 to S63	steps
S64 to S70	steps
S71 to S77	steps
T5, T6	cancel speed

Claims

1. A bicycle shift control device for automatically switching a plurality of speed steps of a shifting mechanism in accordance with the sensed speed of the bicycle, wherein said bicycle shift control device comprises:

   - bicycle speed input means for entering said sensed bicycle speed;
   - first upshift means for switching said speed steps from a lower step to a higher step when said bicycle is in first gear;
   - first downshift means for switching said speed steps from a higher step to a lower step when said bicycle is in second gear;
   - upshift mode setting means for setting an upshift mode when said first upshift means is actuated;
   - second downshift means for switching said speed steps from a higher step to a lower step when said upshift mode has been set, and said bicycle speed has been changed from said second gear to a lower, third gear;
   - downshift mode setting means for setting a downshift mode when said first downshift means has been actuated; and
   - second upshift means for switching said speed steps from a lower step to a higher step when said downshift mode has been set, and said bicycle speed has been changed from the first gear to a higher, fourth gear.

2. A bicycle shift control device for automatically switching a plurality of speed steps of a shifting mechanism in accordance with the sensed speed of the bicycle, wherein said bicycle shift control device comprises:

   - bicycle speed input means for entering said sensed bicycle speed;
   - first upshift means for switching said speed steps from a lower step to a higher step when said bicycle is in first gear;
   - first downshift means for switching said speed steps from a higher step to a lower step when said bicycle is in second gear;
   - upshift mode setting means for setting an upshift mode when said first upshift means is actuated;
   - second downshift means for switching said speed steps from a higher step to a lower step when said upshift mode has been set, and said bicycle speed has been changed from said second gear to a lower, third gear;
   - downshift mode setting means for setting a downshift mode when said first downshift means has been actuated
   - second upshift means for switching said speed steps from a lower step to a higher step when said downshift mode has been set, and said bicycle speed has been changed from the first gear to a higher, fourth gear;
   - upshift mode release means for releasing said upshift mode; and
   - downshift mode release means for releasing said downshift mode.

3. A bicycle shift control device as defined in Claim 2, wherein said upshift mode release means cancels said upshift mode in fifth gear, which is higher than said first gear; and said downshift mode release means cancels said downshift mode in sixth gear, which is lower than said second gear.

4. A bicycle shift control device as defined in Claim 3, wherein said upshift mode release means and downshift mode release means have, respectively, a fifth gear group and a sixth gear group provided with respective settings for the fifth and sixth gears of each of said speed steps.

5. A bicycle shift control device as defined in Claim 4, wherein said downshift mode release means cancels said downshift mode when said bicycle speed reaches a speed that conforms to any of the sixth gears corresponding to said speed steps of said sixth gear group, or when said first or second upshift means is actuated.

6. A bicycle shift control device as defined in Claim 4 or 5, wherein said upshift mode release means cancels said upshift mode when said bicycle speed reaches a speed that conforms to any of the fifth gears corresponding to said speed steps of said fifth gear group, or when said first or second downshift means is actuated.

7. A bicycle shift control device as defined in any of Claims 1 through 6, wherein said first and second upshift means have, respectively, a first gear group and a fourth gear provided with respective settings for said first gear and said fourth gear, which correspond to an upshift at each of the aforementioned speed steps; and said first and second downshift means have, respectively, a second gear group and a third gear group provided with respective settings for said second and third gears, which correspond to a downshift at each of the aforementioned speed steps.

8. A bicycle shift control device for automatically switching a plurality of speed steps of a shifting mechanism in accordance with the sensed speed of the bicycle, wherein said bicycle shift control device comprises:

- bicycle speed input means for entering said sensed bicycle speed;
- upshift means for upshifting the speed steps when said bicycle speed rises above speed A;
- first shift maintenance means for maintaining said upshifted speed steps when said bicycle speed has exceeded speed A but is still below a higher speed B;
- first downshift means for downshifting the speed steps maintained by said first shift maintenance means when said bicycle speed has dropped to speed C, which is lower than speed A;
- second shift maintenance means for maintaining said upshifted speed steps when said bicycle speed has exceeded speed B but is still below a higher speed D; and
- second downshift means for downshifting the speed steps maintained by said second shift maintenance means when said bicycle speed has dropped to speed E, which is lower than speed B but higher than speed A.

9. A bicycle shift control device for automatically switching a plurality of speed steps of a shifting mechanism in accordance with the sensed speed of the bicycle, wherein said bicycle shift control device comprises:

- bicycle speed input means for entering said sensed bicycle speed;
- downshift means for downshifting the speed steps when said bicycle speed has dropped below speed A;
- first shift maintenance means for maintaining said downshifted speed steps when said bicycle speed has dropped below speed A but is still above a lower speed B;
- first upshift means for upshifting the speed steps maintained by said first shift maintenance means when said bicycle speed has risen to speed C, which is higher than speed A;
- second shift maintenance means for maintaining said upshifted speed steps when said bicycle speed falls within a range between speed B and a lower speed D; and
- second upshift means for upshifting the speed steps maintained by said second shift maintenance means when said bicycle speed has risen to speed E, which is higher than speed B but lower than speed A.

FIG. 1

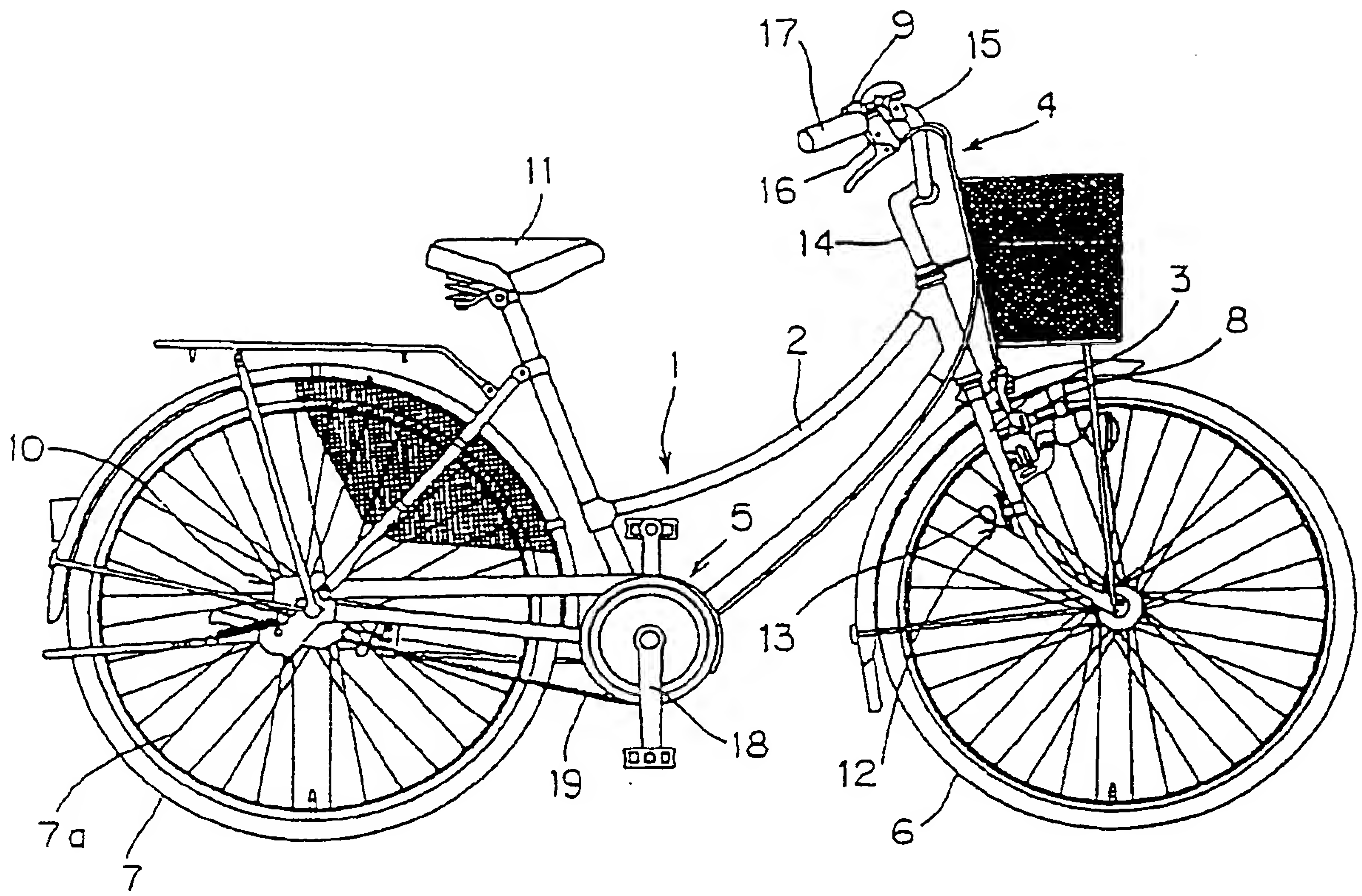


FIG. 2

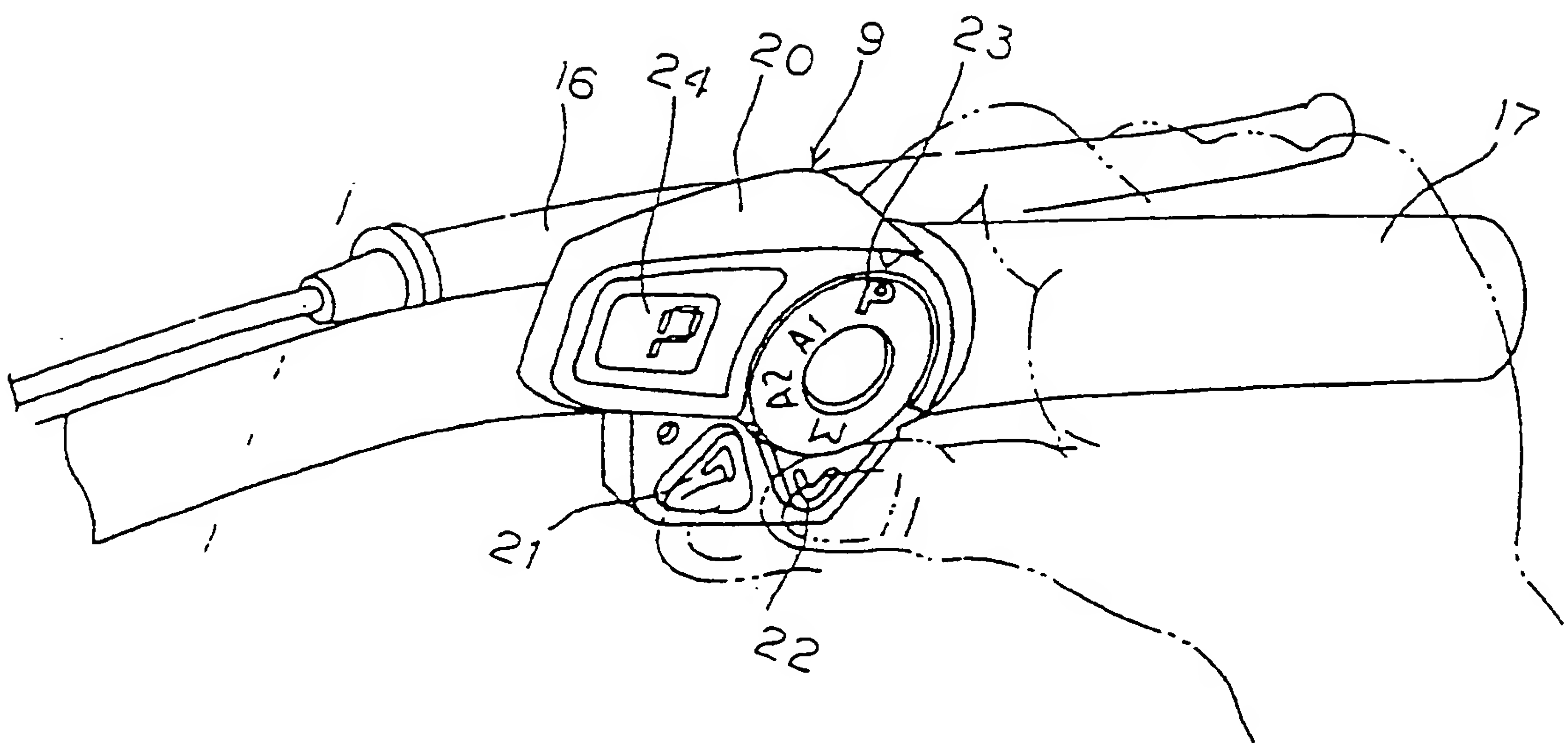


FIG. 3

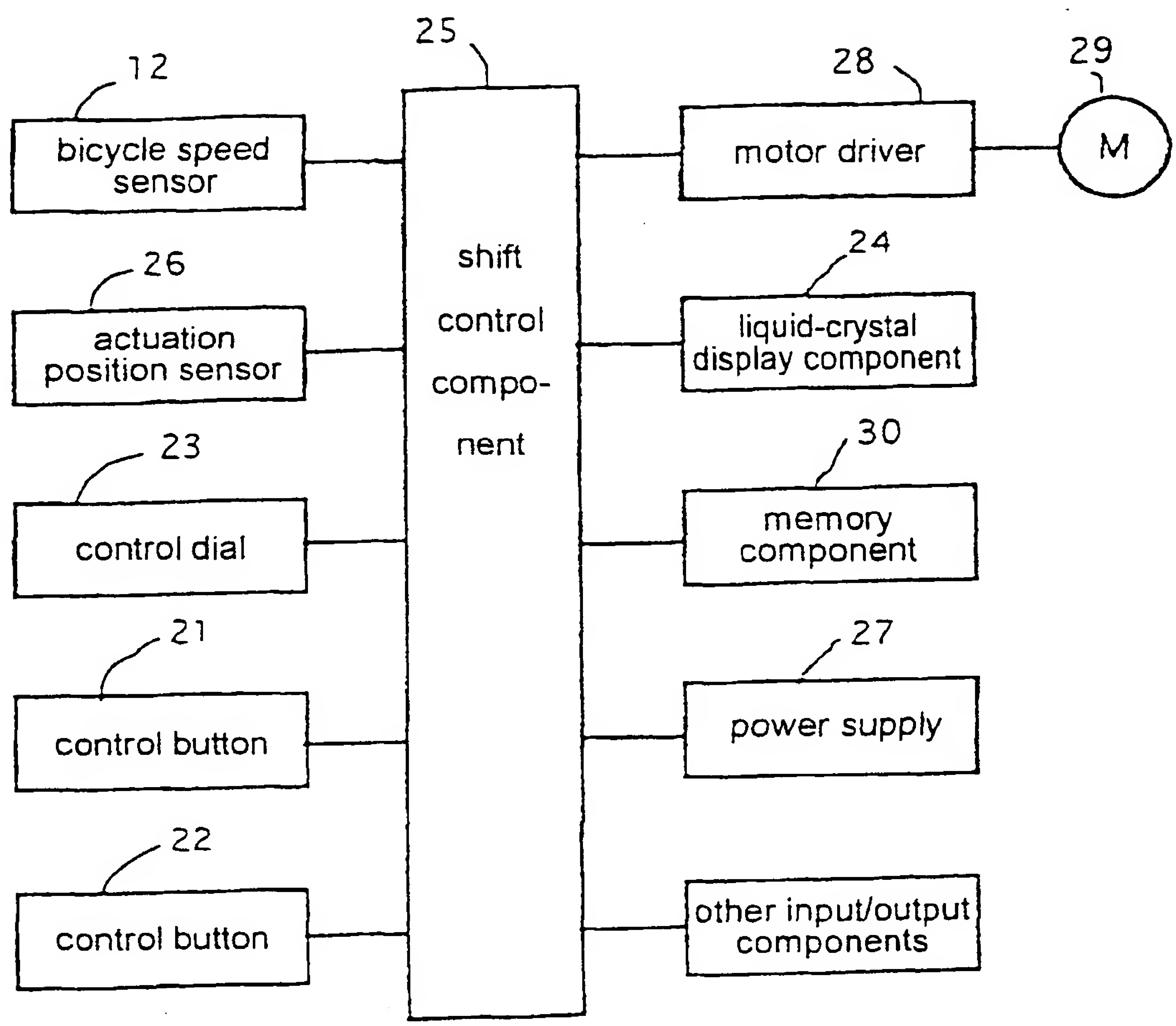

25
12
bicycle speed sensor
26
actuation position sensor
23
control dial
21
control button
22
control button
shift control compo-nent
28
motor driver
29
M
24
liquid-crystal display component
30
memory component
27
power supply
other input/output components

FIG. 4

Speed step (VP)	Speed (T(VP))	Speed (T(VP))
	Table 1 (T1)	Table 2 (T2)
1	0	12
2 (2 → 1)	9	12
3 (3 → 2)	14	17
4 (4 → 3)	18	21
	Table 3 (T3)	Table 4 (T4)
1 (1 → 2)	11	14
2 (2 → 3)	16	19
3 (3 → 4)	20	23
4	255	255
	Table 5 (T5)	Table 6 (T6)
1	8	0
2	14	14
3	17	19
4	255	23

FIG. 5

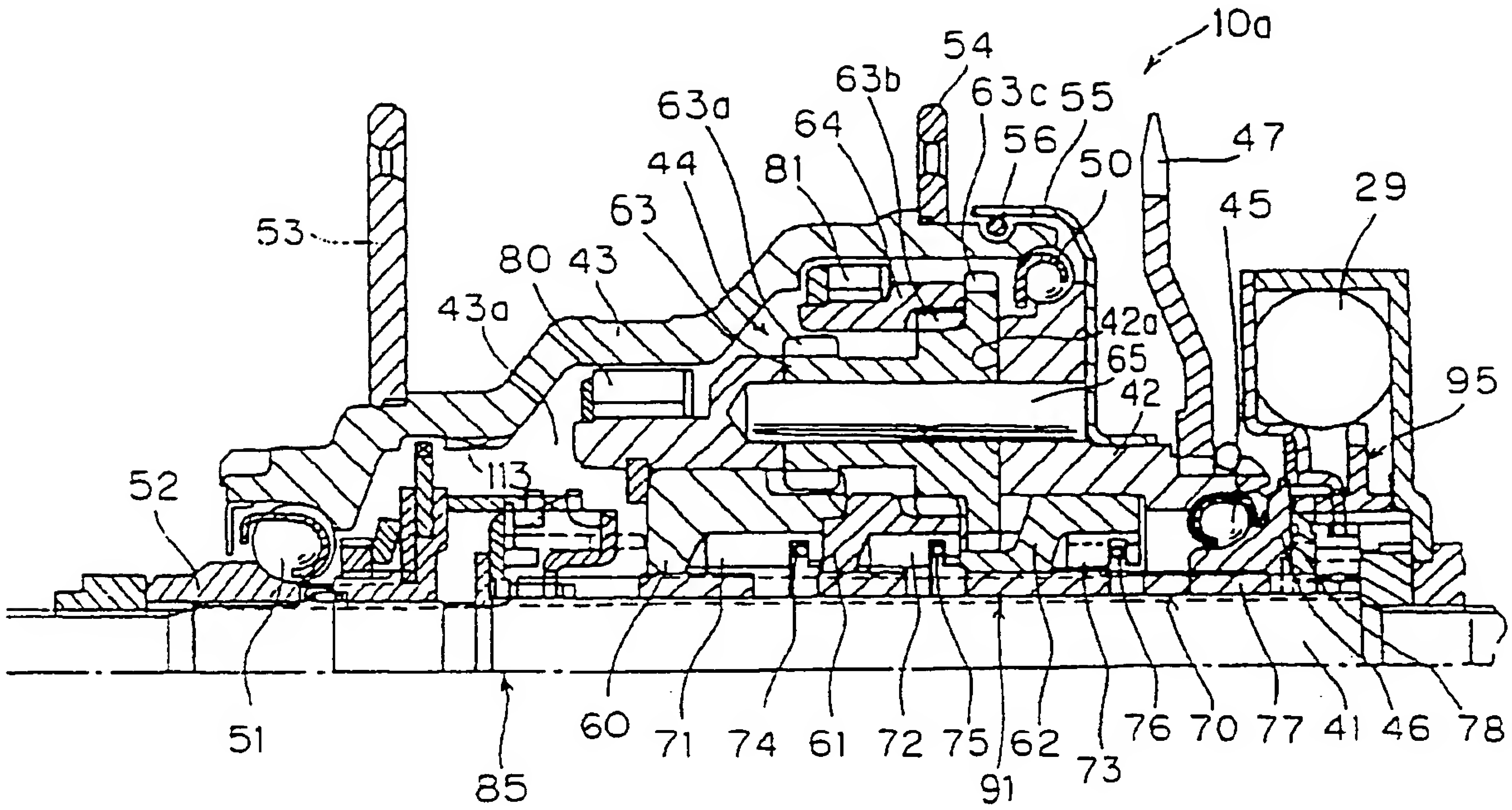
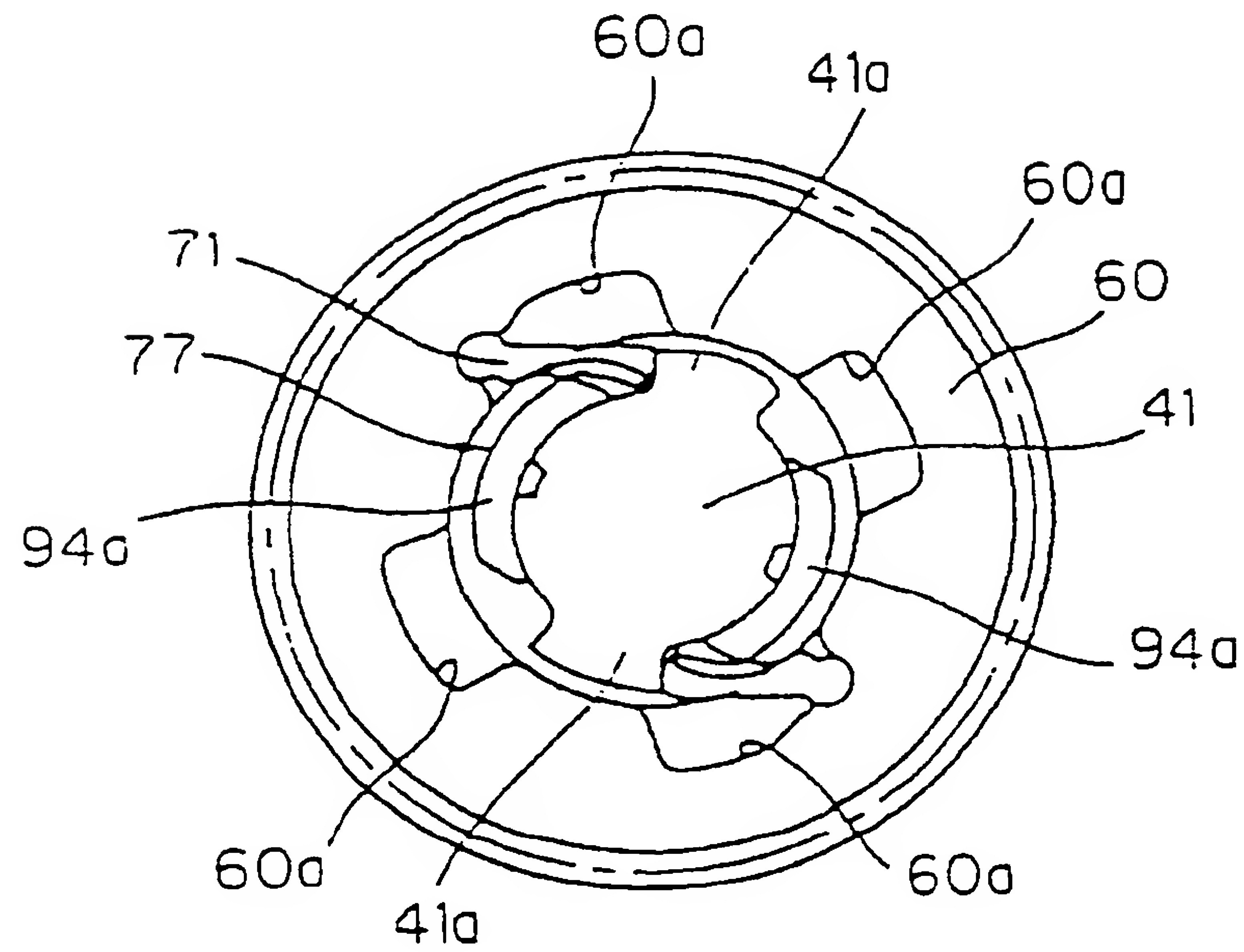

10a
54
63b
63c
55
63a
64
56
47
44
81
50
45
29
53
63
80
43
43a
42a
65
42
95
113
52
51
85
60
71
74
61
72
75
91
62
73
76
70
77
41
46
78

FIG. 6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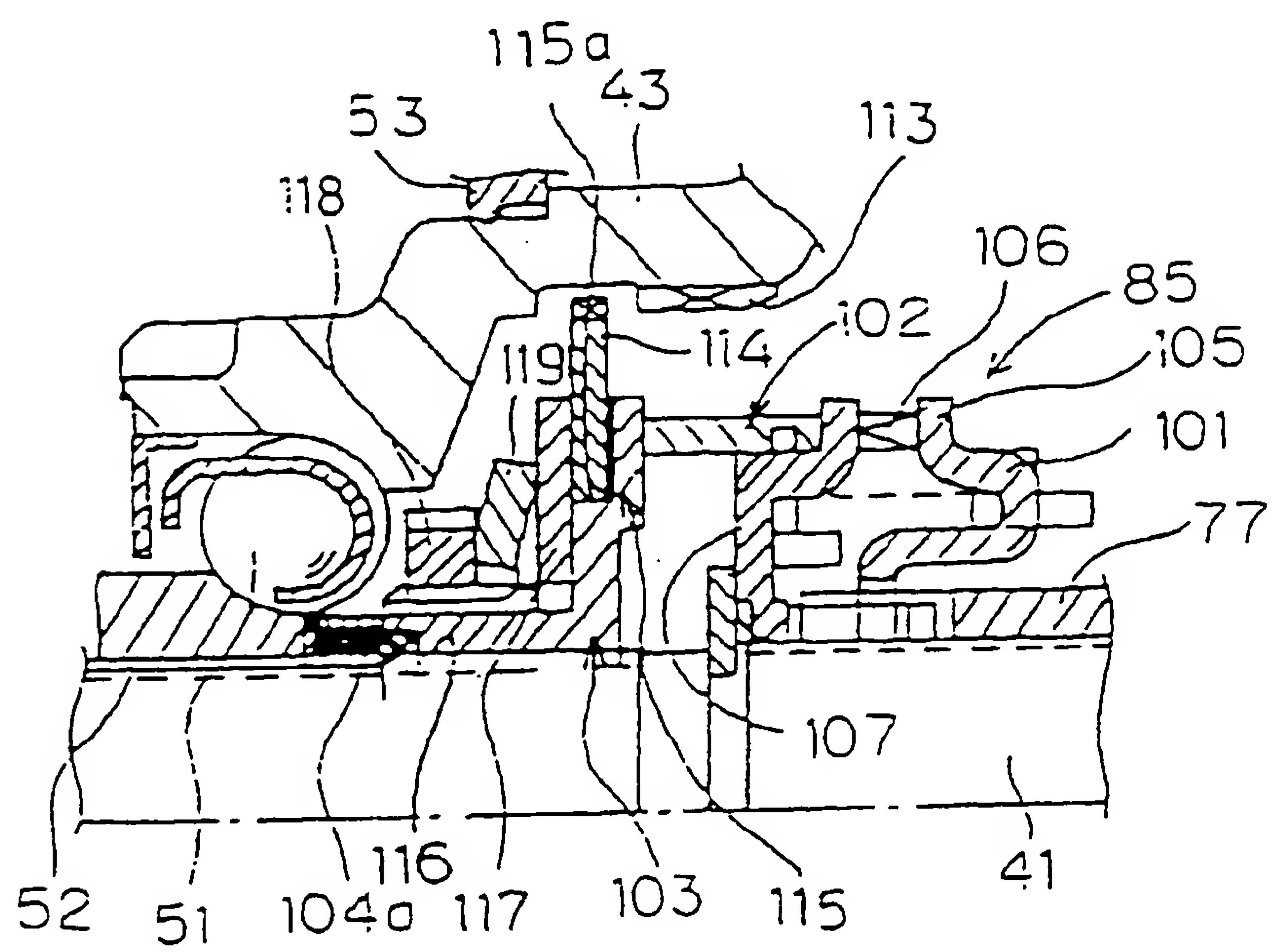
60a
71
60
77
41
94a
94a
60a
41a
60a

FIG. 7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43
53
113
118
106
85
114
102
105
119
101
77
107
52
51
104a
116
117
103
115
41

FIG. 8

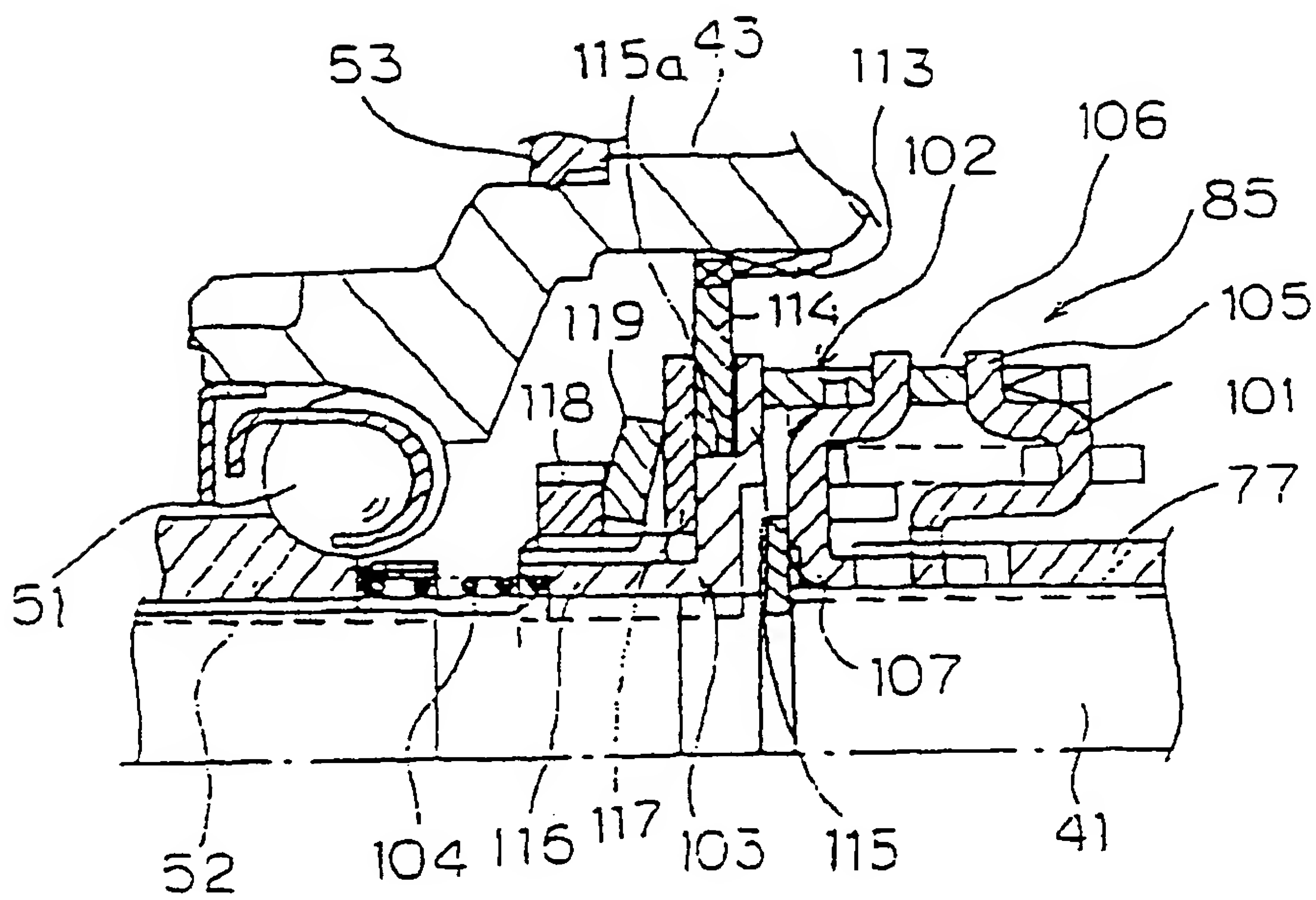

53
115a
43
113
102
106
85
105
119
114
118
101
77
51
107
52
104
116
117
103
115
41

FIG. 9

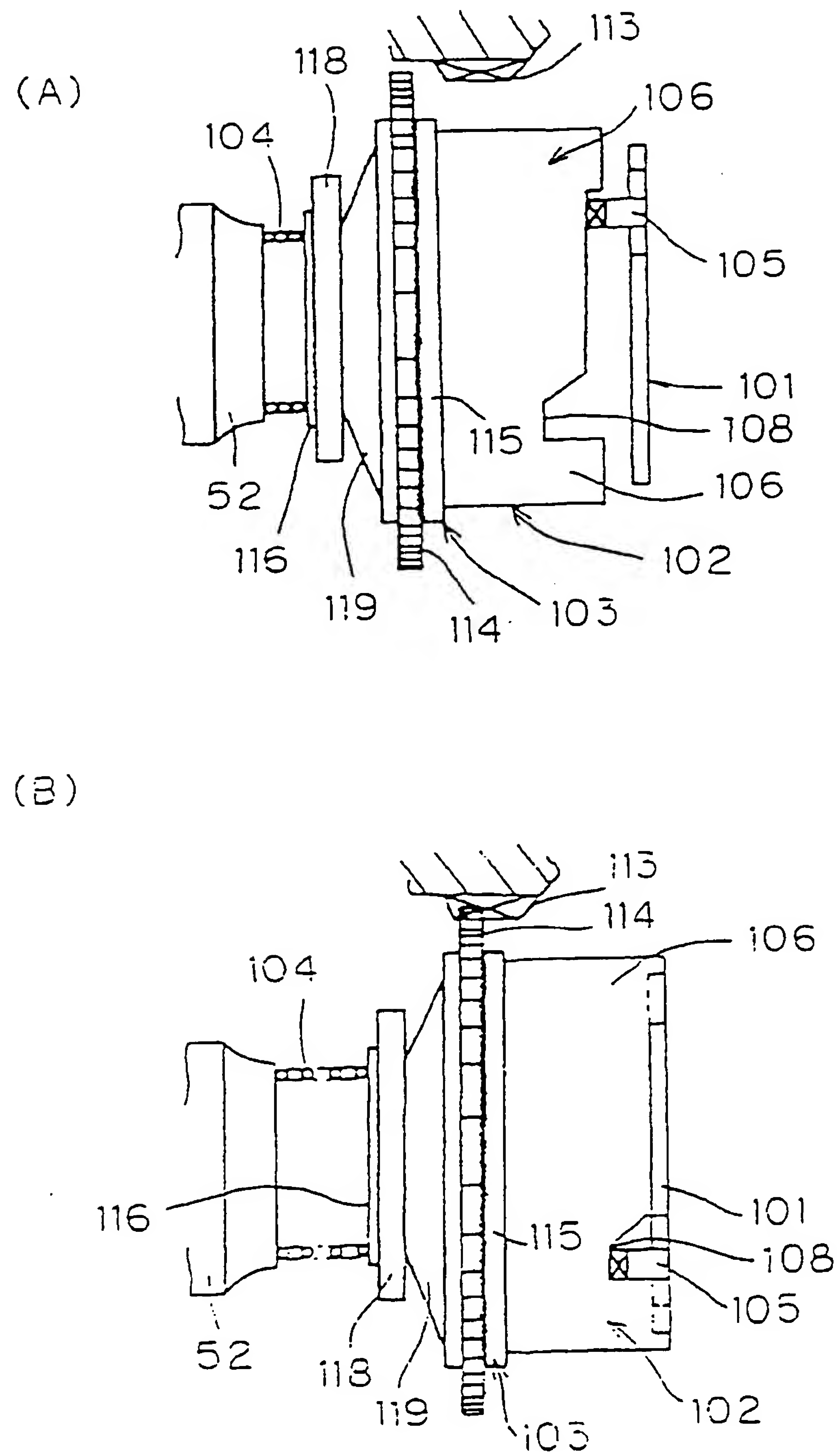

(A)
113
118
106
104
105
101
115
108
52
106
116
102
119
114
103
(B)
113
114
106
104
116
101
115
108
105
52
118
119
102
103

FIG. 10

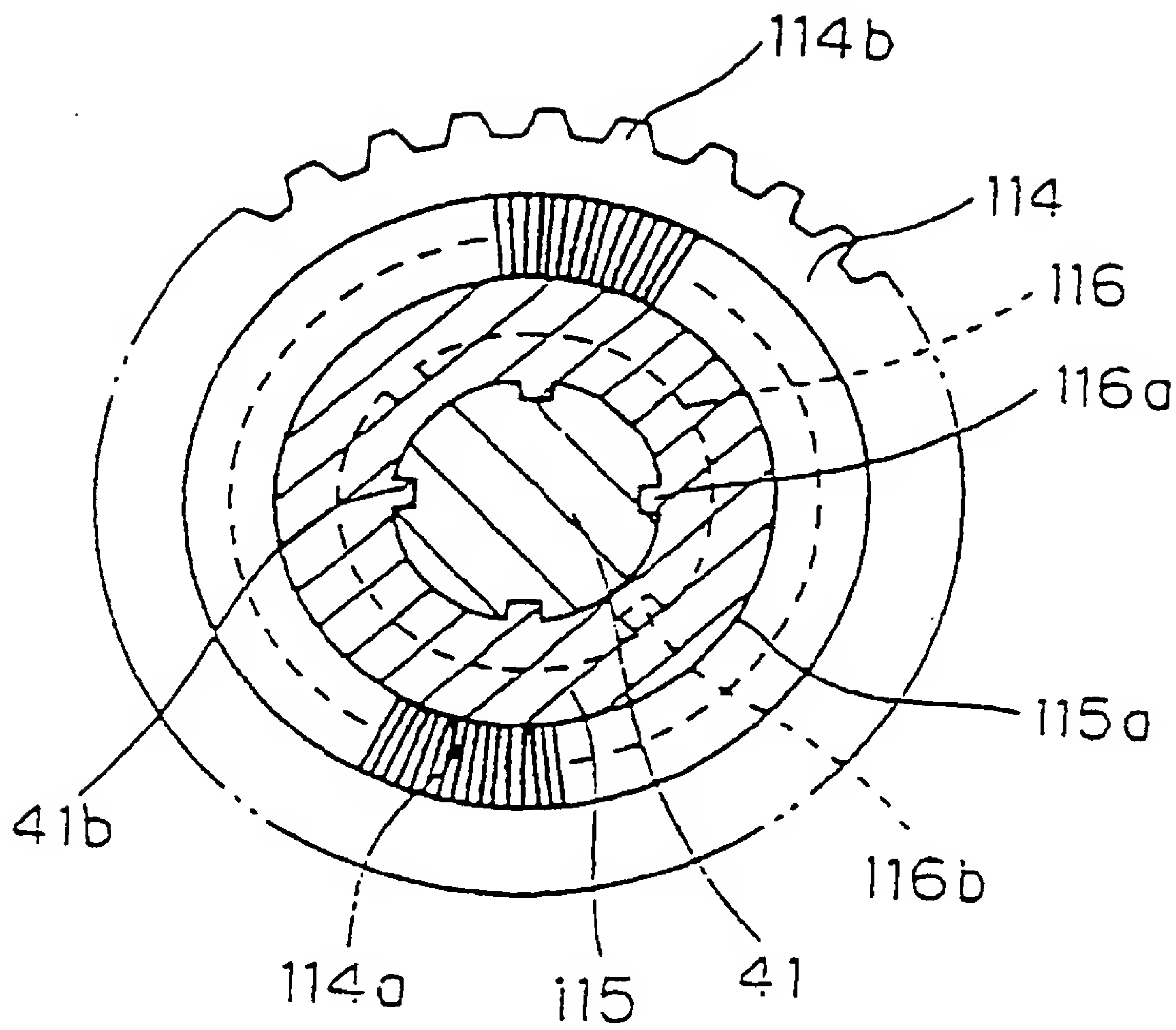


FIG. 11

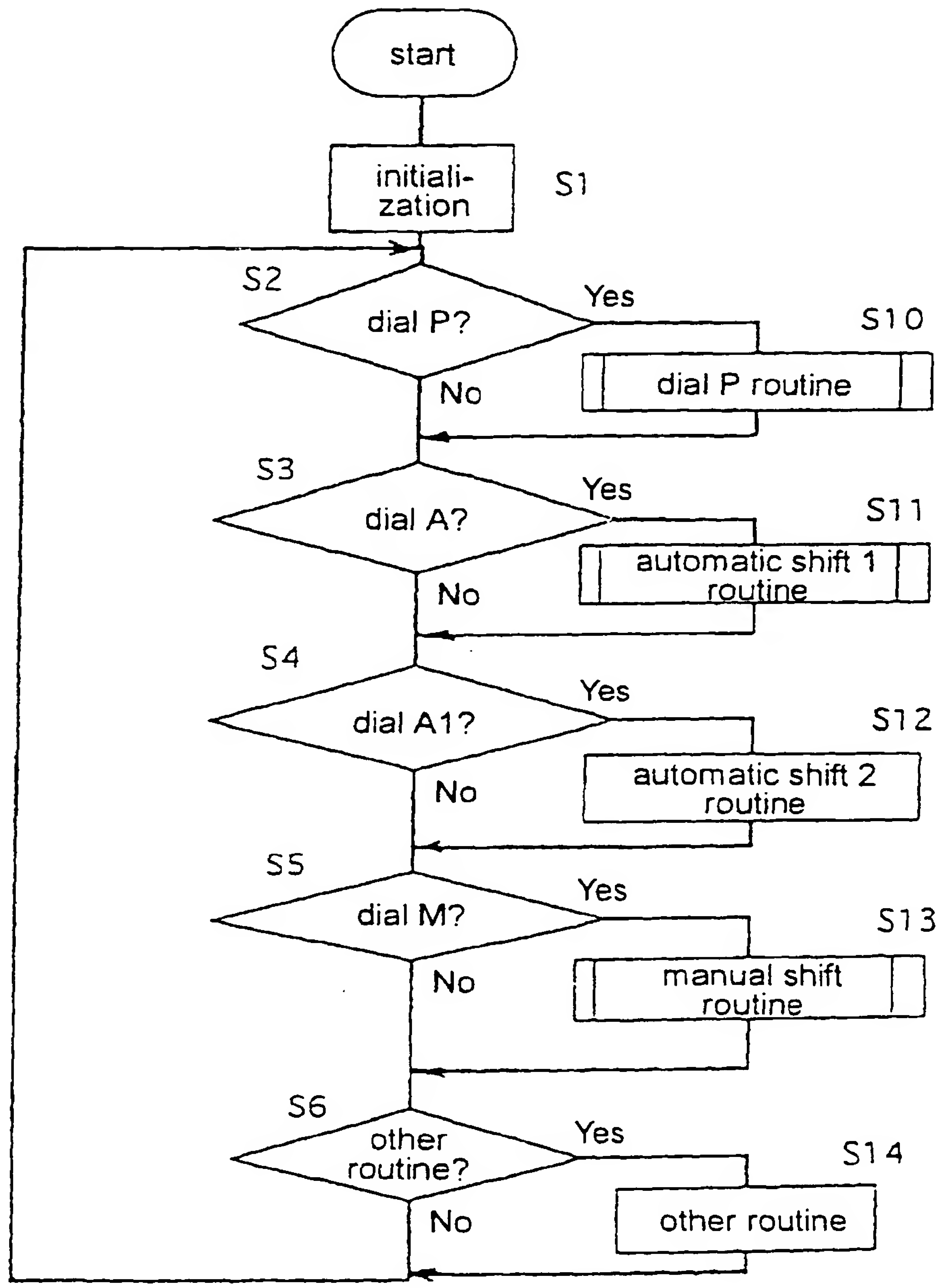

start
initiali-
zation
S1
S2
dial P?
Yes
No
S10
dial P routine
S3
dial A?
Yes
No
S11
automatic shift 1
routine
S4
dial A1?
Yes
No
S12
automatic shift 2
routine
S5
dial M?
Yes
No
S13
manual shift
routine
S6
other
routine?
Yes
No
S14
other routine

FIG. 12

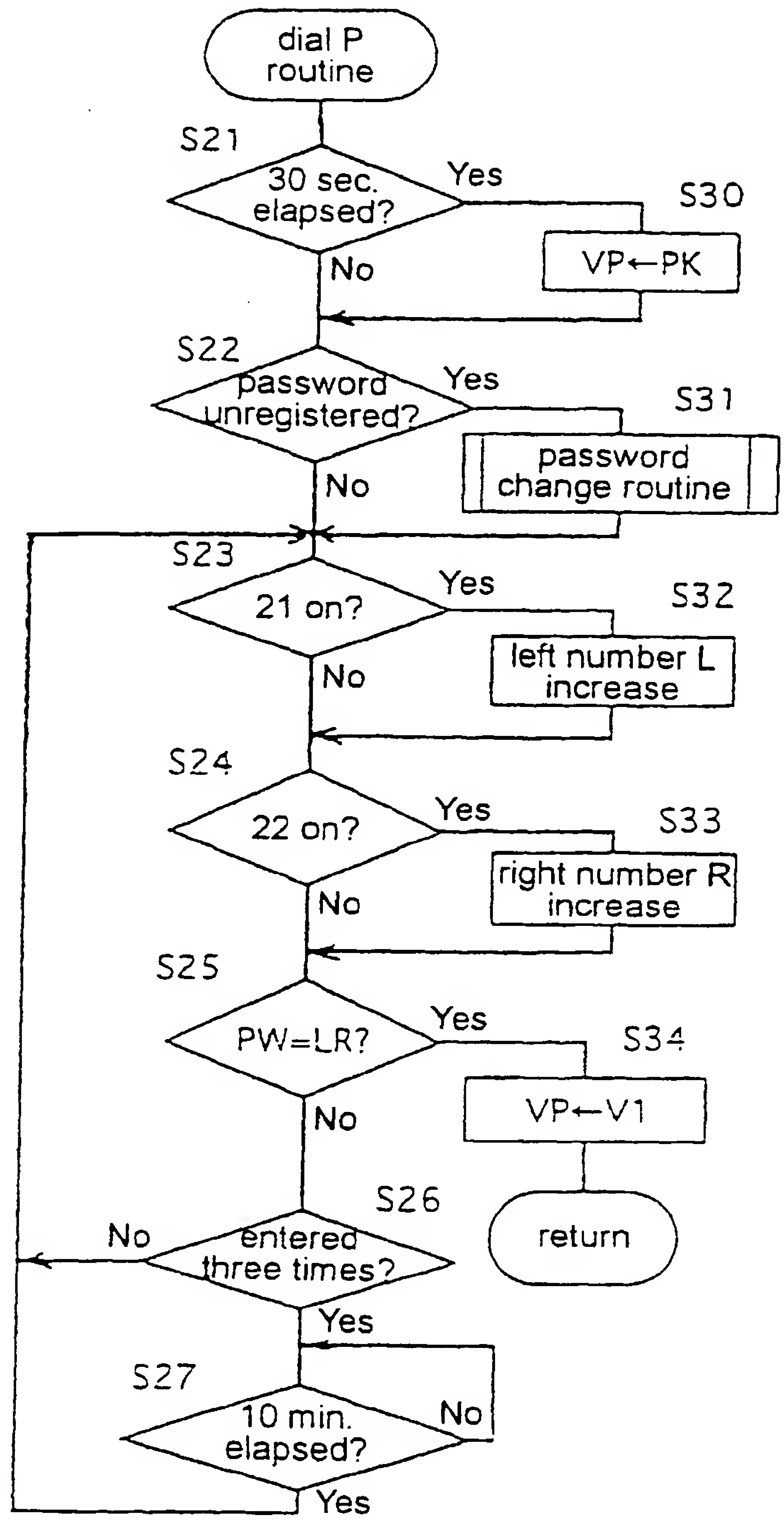

dial P routine
S21
30 sec. elapsed?
Yes
No
S30
VP←PK
S22
password unregistered?
Yes
No
S31
password change routine
S23
21 on?
Yes
No
S32
left number L increase
S24
22 on?
Yes
No
S33
right number R increase
S25
PW=LR?
Yes
No
S34
VP←V1
return
S26
entered three times?
No
Yes
S27
10 min. elapsed?
No
Yes

FIG. 13

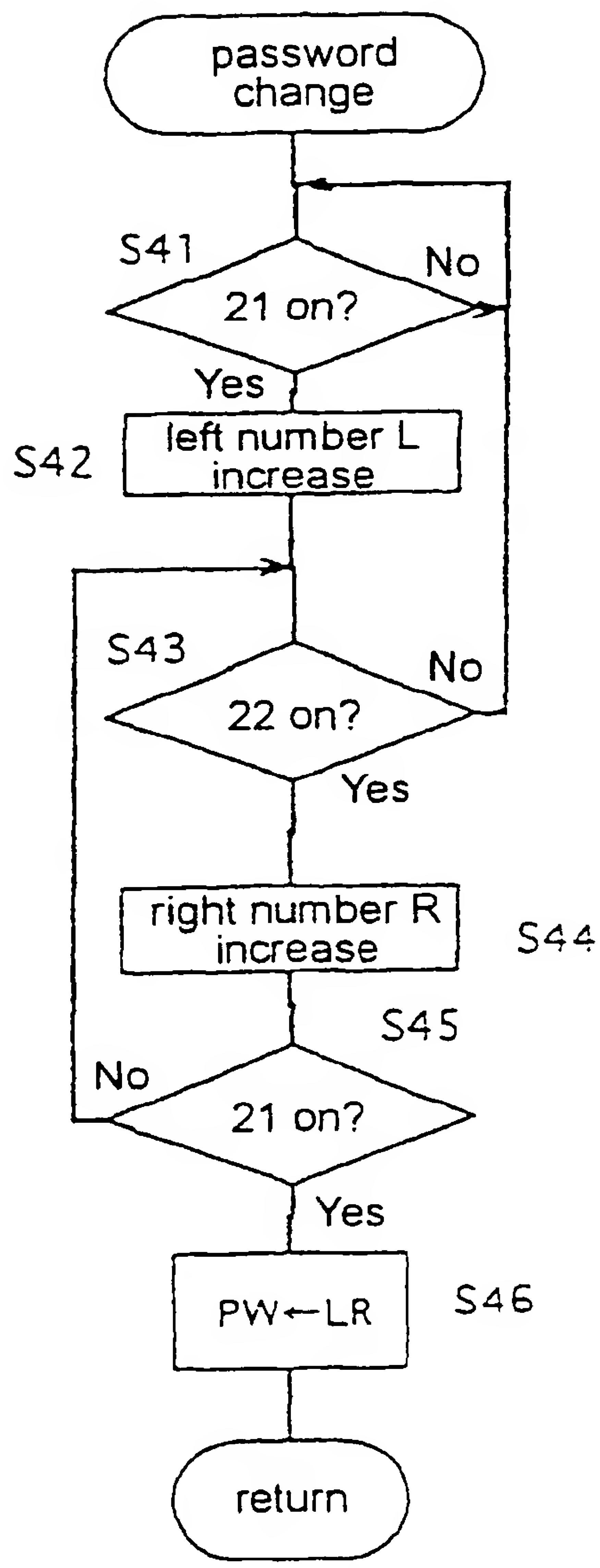

password change
S41
21 on?
No
Yes
S42
left number L increase
S43
22 on?
No
Yes
right number R increase
S44
S45
No
21 on?
Yes
PW←LR
S46
return

FIG. 14

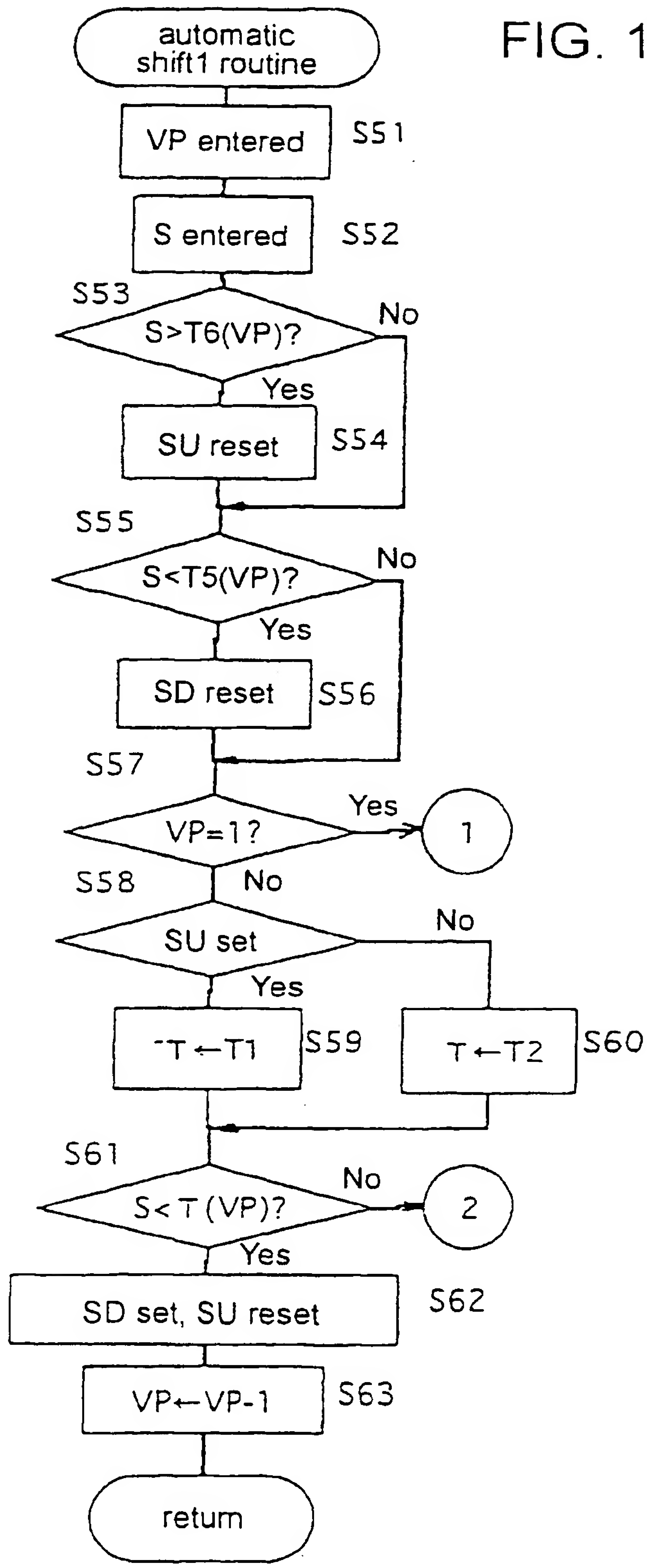

automatic shift1 routine
VP entered
S51
S entered
S52
S53
S>T6(VP)?
No
Yes
SU reset
S54
S55
S<T5(VP)?
No
Yes
SD reset
S56
S57
VP=1?
Yes
1
S58
No
SU set
No
Yes
T←T1
S59
T←T2
S60
S61
S< T (VP)?
No
2
Yes
SD set, SU reset
S62
VP←VP-1
S63
return

FIG. 15

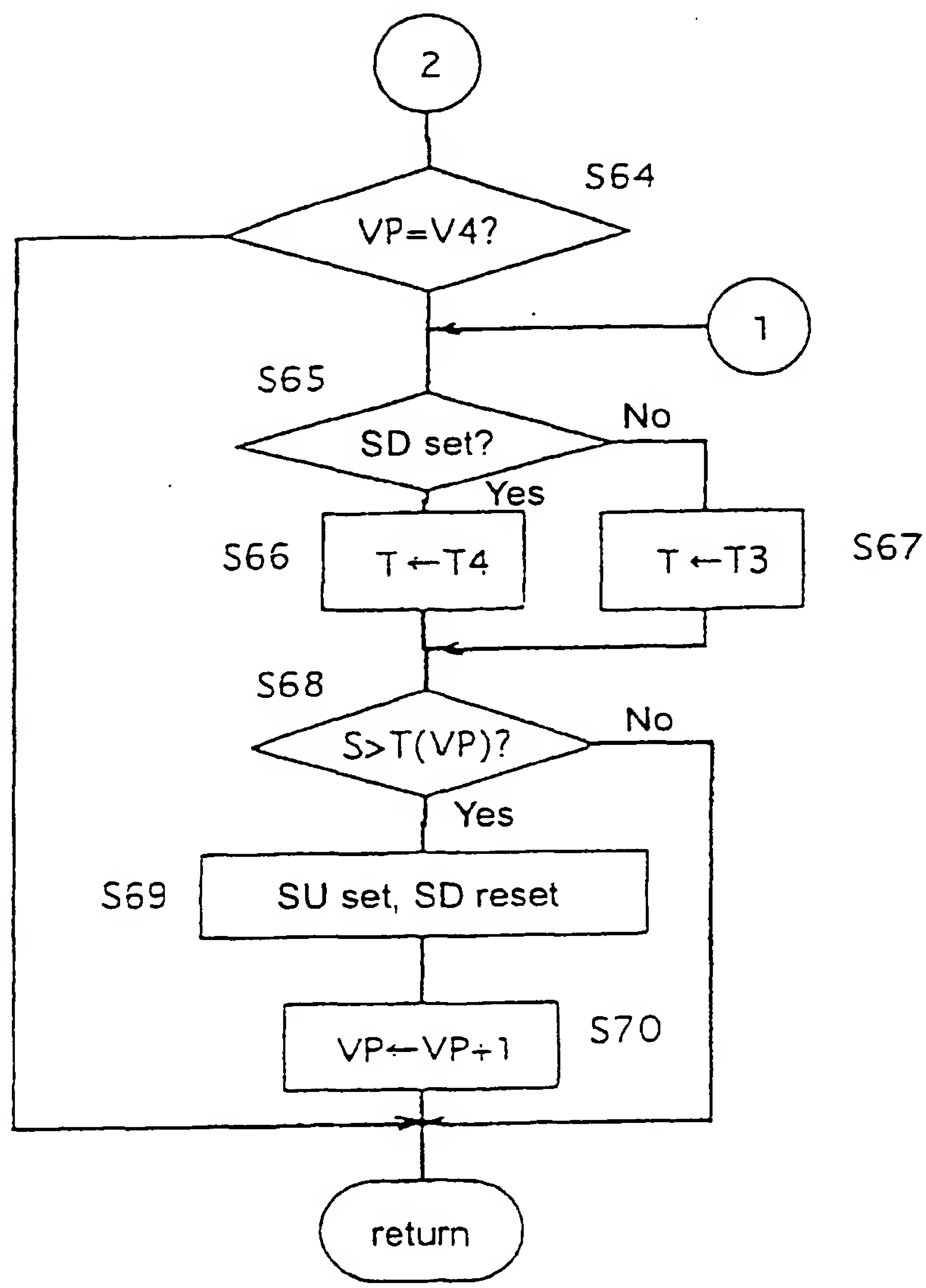
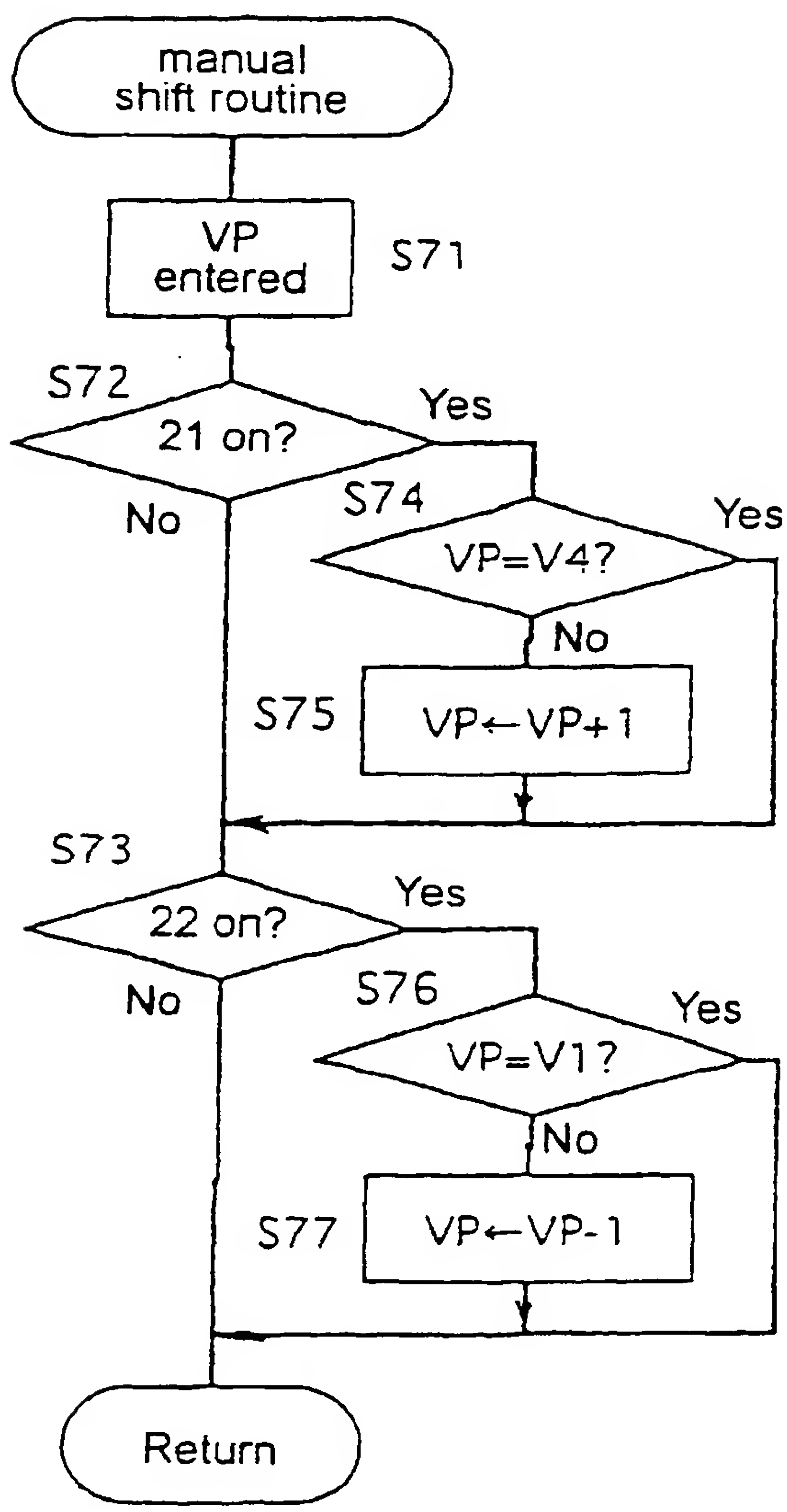

2
S64
VP=V4?
1
S65
SD set?
No
Yes
S66
T←T4
T←T3
S67
S68
S>T(VP)?
No
Yes
S69
SU set, SD reset
VP←VP+1
S70
return

FIG. 16


manual shift routine
VP entered
S71
S72
21 on?
Yes
No
S74
VP=V4?
Yes
No
S75
VP←VP+1
S73
22 on?
Yes
No
S76
VP=V1?
Yes
No
S77
VP←VP-1
Return

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(71) Applicant: **SHIMANO INC.**
Osaka 590-8577 (JP)

(72) Inventor: **Kimura, Yoshiki**
Shimonoseki-shi, Yamaguchi (JP)

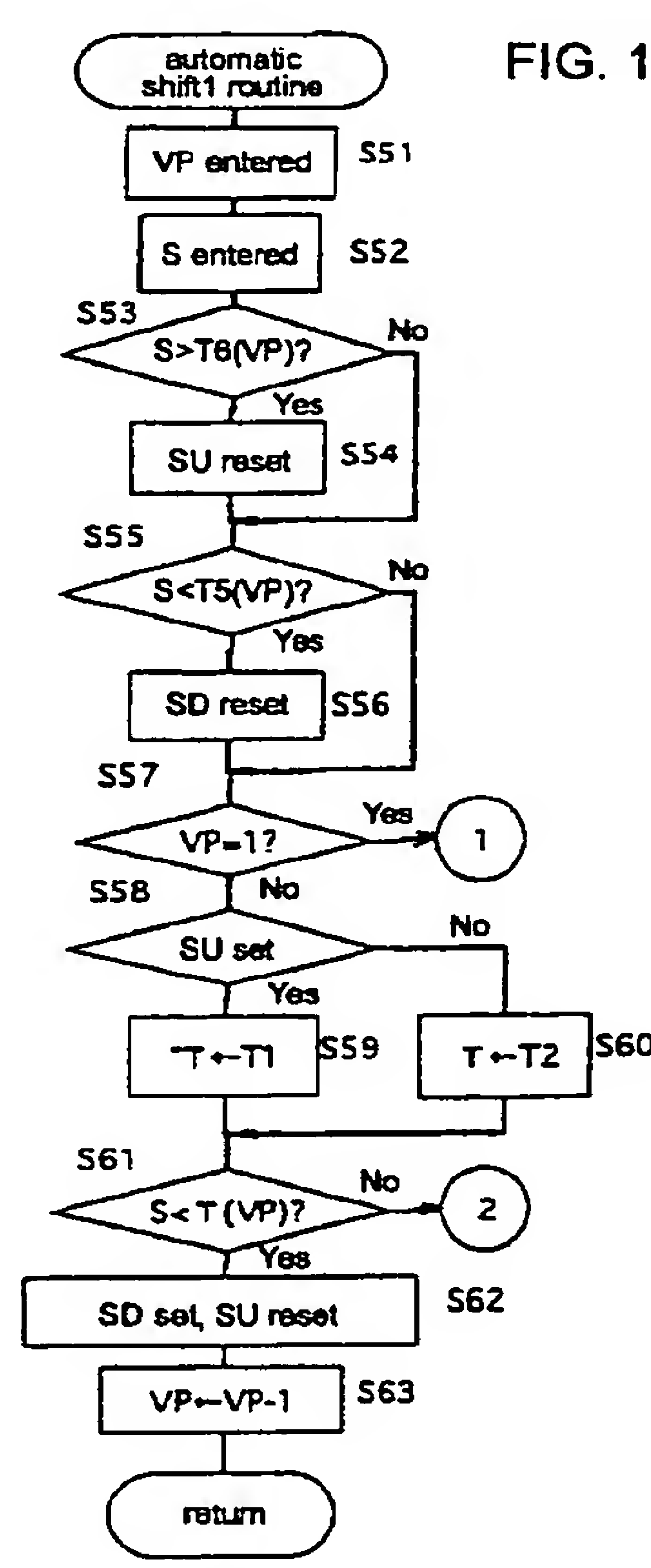
(74) Representative:
Herrmann-Trentepohl, Werner, Dipl.-Ing.
Patentanwälte
Herrmann-Trentepohl
Grosse - Bockhorni & Partner
Forstenrieder Allee 59
81476 München (DE)

(54) **Bicycle shift control device**

(57) To provide a bicycle shift control device that is unlikely to cause discomfort during a shifting procedure based on a simple control routine.

With the shift control component 25, speed steps are raised to the next level when the bicycle accelerates or is in first gear. An upshift mode is established. In this upshift mode, the speed steps are kept unchanged until they are in third gear (which is lower than the second gear), and are switched to a lower level when they are in third gear. On the other hand, the speed steps are switched to a lower level when they reach the second gear during deceleration if the upshift mode is not established. A downshift mode is established. In this downshift mode, the speed steps are kept unchanged until they are in fourth gear (which is higher than the first gear), and are switched to a higher level when they are in fourth gear. An upshift mode or a downshift mode is established when a shift is performed, the speed is changed to a gear (fourth or third) different from the regular shift gear (first or second), and shift timing is slowed down.

FIG. 14



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EUROPEAN SEARCH REPORT

Application Number
EP 98 11 5940

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	US 5 261 858 A (BROWNING DAVID L) 16 November 1993 (1993-11-16) * column 6, line 17 - line 47 *	1	B62M25/08 B62M11/14
A	US 5 599 244 A (ETHINGTON RUSSELL A) 4 February 1997 (1997-02-04) * column 15, line 52 - column 16, line 28; figure 8 * * column 4, line 64 - column 5, line 12 *	1	
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TECHNICAL FIELDS SEARCHED (Int.Cl.6)

B62M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	8 June 2000	Cauderlier, F

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08-06-2000

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